A CONSTRUCTABILITY STUDY OF THE SARGENT BEACH, TEXAS EROSION CONTROL PROJECT

by

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ABSTRACT

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This thesis presents an analysis of the US Army Corps of Engineers' Sargent Beach, Texas Erosion Control Project and makes recommendations concerning risk assessment, project controls, and contracting strategy in order to maximize the chances of overall project success. The main source of data for the study was a constructability symposium conducted for the purpose of soliciting input into the project planning and design process from construction contractor representatives experienced in the field of heavy marine construction. This thesis also examines the elements of a successful constructability symposium, and models that and other options available to the Corps of Engineers and other public sector entities for gaining construction contractor input into project planning and design.

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CHAPTER 1
INTRODUCTION

1.1 Purpose

The purpose of this thesis is to analyze the US Army Corps of Engineers' Sargent Beach, Texas Erosion Control Project and to make recommendations concerning risk assessment, project controls, and contracting strategy in order to maximize the chances of overall project success. In addition, this thesis will examine options available to the Corps of Engineers and other public sector entities for getting construction contractor input into the project planning and design process.

1.2 Scope

This thesis relates to part of a constructability study undertaken by the Construction Industry Institute (CII) on behalf of the US Army Corps of Engineers Galveston District Office. It analyzes recommendations and comments made at a constructability symposium by contractor representatives experienced in the field of heavy marine construction. Using the contractor representatives' comments, as well as literature and information solicited from Corps of Engineers (COE) project management and design personnel, various courses of action are examined, and relative advantages and disadvantages are identified. These advantages and disadvantages are weighed, and recommendations are made for actions the COE should take in organizing the project and preparing the contract documents.

Following this, various options available to the COE and other public sector entities for getting construction contractor input into the project planning and design process are detailed. The constructability symposium method is then examined in depth to identify the elements that are crucial to symposium success.

1.3 Study Organization

This chapter has provided a brief description of the purpose and scope of the study. The remaining chapters are described below.

Chapter 2 provides a detailed description of the Sargent Beach Erosion Control Project, and also defines the concept of constructability. Chapter 3 describes the conduct of the CII constructability study, with particular emphasis on *the constructability* symposium which was the primary data collection technique. Chapters 4 and 5 present the analysis of the risk assessment and project control strategies, respectively, of the Sargent Beach project. Chapter 6 summarizes the conclusions and Chapter 7 summarizes the recommendations on risk assessment and project controls. Chapter 8 describes the Corps of Engineers' existing design review system, describes some perceived weaknesses in this system, and models several options available to the COE or other public sector entities for gaining contractor input into the project planning and design process. In addition, Chapter 8 examines the constructability symposium option in greater depth, and analyzes the contractor participants' perceptions of the constructability symposium that was conducted as part of this study. The appendices contain supporting documentation.

CHAPTER 2

BACKGROUND

2.1 Project Description

The Gulf Intracoastal Waterway (GIWW) is a critical component of the inland waterway navigation system of the United States. In Texas, the GIWW extends along the entire coast of the Gulf of Mexico, and links, among others, the Houston, Galveston, and Freeport, Texas areas with such downcoast cities as Corpus Christi and Brownsville. It also links Texas' ports to much of the United States' industrial heartland, via the Mississippi and other connecting rivers, and thus supports a significant sector of the United States' economy.

The GIWW was constructed in stages, with the last section being completed in 1949. In most of the Texas section of the GIWW, the waterway is well-protected from Gulf of Mexico wave action by either barrier islands or land cuts linking major bay systems. The reach passing near the community of Sargent, Texas, however, was built relatively close to the coast and so is protected only by a narrow strip of land. A map of the area is shown in Appendix A.

In the Sargent Beach area, excessive erosion of the silt material making up the barrier island separating the waterway from the Gulf of Mexico threatens the continued operation of this section of the GIWW. Along this approximately eight-mile long stretch, the shoreline is eroding at an average rate of between 25 and 35 feet per year (COE 1992, GIWW Section 216 Study).

There are few, if any, dunes on this section of coast; the maximum elevation along this stretch is about seven feet above mean low tide (MLT). If the strip of

land separating the GIWW from the Gulf becomes too narrow, then waves will increasingly overtop the beach, with the water draining down into the GIWW. As the water flows down into the GIWW, it will erode the soil and cause sediment to build up in the navigation channel of the GIWW. Such a buildup will necessitate more frequent maintenance dredging of the channel in order to keep it navigable, with an attendant increase in costs.

The possibility of the Gulf waters physically breaking through or breaching the remaining strip of land is an additional threat to the GIWW. Such a breach would subject GIWW traffic to Gulf wave action and possibly dangerous currents, and would thus seriously impede, if not stop, such traffic. In order to keep the GIWW navigable, any such breaches would have to be plugged and the channel dredged to remove any sediment buildup.

As the strip of land separating the GIWW from the Gulf gets progressively narrower, the frequency of overtopping and breaching will increase, eventually reaching the point where it is no longer economically feasible to keep this stretch of the GIWW open. At the present rate of erosion, the COE estimates that the barrier beach will narrow to the point where serious maintenance problems will develop in this section of the GIWW by the year 2000, and that by 2014 this section of the GIWW would permanently close to commercial barge traffic(COE 1992, GIWW Section 216 Study). Closure of this section of the waterway would seriously disrupt the present system of water transport and have a severe economic impact on industries and communities along much of the Gulf coast.

In response to this alarming scenario, the US Congress directed the US Army Corps of Engineers, which shares responsibility for operation of the GIWW

with the US Coast Guard, to study the problem and devise possible solutions. The COE considered several alternatives, and after detailed economic and environmental analysis, recommended construction of a stone revetment along the threatened reach, with a design life of 50 years.

2.2 Description of the Revetment .

The detailed design for the project is being done by the COE's Galveston District, with assistance from the COE's Waterways Experiment Station in Vicksburg, Mississippi and a private consulting engineering firm working under what is termed an "indefinite delivery contract."

The proposed structure is 41,992 feet, or approximately eight miles, long, and runs generally parallel to the GIWW. The crest of the structure will be located 300 feet from the south bank of the GIWW, as this is the minimum distance required to prevent serious wave overtopping and yet still permit construction to take place "in the dry" (i.e. on land, as opposed to in the surf zone), given the present rate of erosion.

The cross section of the structure will vary according to the soil conditions, but will be one of five basic types:

a. 1V:2.5H sloping revetment

b. 1V:5H sloping revetment

c. Sheet pile wall section

d. Transition section

e. End section

Cross sections of the 1V:2.5H and 1V:5H sloping revetments and the sheet pile wall sections are shown in Appendix B.

There are three separate sections, totaling 30,010 feet, representing approximately 72% of the revetment length, consisting of the 1V:2.5H sloping revetment. The toe element of these sections will be at elevation -10 feet MLT, with a 1V:2.5H sloping stone revetment, and a cap section of stone rising to an elevation of seven feet above MLT. The revetment armor consists of 5 3/4 x 5 3/4 x 2 1/2 feet precast concrete units weighing some six tons each. The armor units rest on a two foot thick layer of blanket stone, defined as reasonably well-graded rock ranging in size from 1/2 inch to 200 pounds. The toe will be protected by toe stone consisting of material graded from 200 to 4000 pounds, while the core stone, which will be used to make the cap, will range in weight from 200 to 2000 pounds. Following stone placement, the excavated material will be backfilled over the toe and much of the sloping revetment to restore the area.

Poor foundation conditions require that one section of the revetment, approximately 2700 feet long, be built upon lifts of compacted clay backfill, and the revetment laid back on a 1V:5H slope. Other features of this revetment section are essentially the same as the standard section.

Even worse soil conditions in two other sections, one 3440 feet long and the other about 1000 feet in length, preclude use of the stone revetment altogether, and require that precast concrete sheet piling be used instead. The piling will vary between 41 and 47 feet in length, and will be topped with a concrete pile cap. Armor units will be placed on the seaward side of the sheet pile wall, at an elevation of five feet below MLT. The armor units will again rest on a bed of

blanket stone, and the toe will be protected by core stone. A splash apron, also of core stone, will be built just landward of the sheet pile wall. As with the stone revetment sections, excavated material will be backfilled to restore the area.

Transition sections of precast concrete armor units will be built to tie the different sections together. End sections, also using the basic stone revetment design, will be built at the east and west ends of the structure in order to tie it back in to the shoreline. Vegetation will be restored along the length of the structure for esthetic and erosion control purposes.

Construction of the revetment will require an estimated 68,000 armor units, 2110 sheet piles, and some 318,000 tons of blanket stone, 70,000 tons of core stone, and 173,000 tons of toe stone. Well over one million cubic yards of earth will have to be excavated and then backfilled to build the structure (COE 1992, GIWW Section 216 Study).

It should be noted that, as of this writing, engineering and design activities are continuing, and the final design, lengths of the various sections, and material quantities may vary as the plans are refined.

As previously mentioned, the proposed structure is to be built essentially in the center of the remaining strip of land separating the GIWW from the Gulf of Mexico. This is being done in order to permit construction to be done as efficiently as possible. Eventually, the beach remaining between the structure and the Gulf will erode back to the revetment, at which point the structure will arrest the erosion, prevent excessive wave overtopping, and prevent the Gulf from breaking through to the waterway, thereby safeguarding the GIWW.

2.3 Constructability Defined

Constructability is a relatively new term to the construction industry. The Construction Industry Institute (CII) defines constructability as "the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives" (CII 1986).

The constructability concept was born out of the realization that designers and contractors have different perspectives of looking at the same project, and that to optimize the project requires that both parties' knowledge and experience be applied to the project planning and design processes. Ideally, construction expertise would begin to be incorporated from the moment of project inception.

The benefits that should accrue from the application of constructability include:

- Reduced cost
- Shorter schedules
- Improved quality
- Enhanced safety
- Better control of risk
- Fewer change orders
- Fewer claims

These benefits are the result of an expansion of front-end planning and the investment of additional effort to anticipate and prevent potential problems. Such efforts must be owner driven (CII 1987).

Private sector construction is generally well-suited for employing constructability concepts. Private sector owners are usually free to select the

contractor of their choice at any point in the project life cycle. As long as payment terms can be negotiated, the contractor can be required to participate throughout the planning and design process. In this way, the contractor's input into the project can be maximized.

Public sector owners such as the Corps of Engineers generally do not have such latitude. Regulatory requirements for public agencies in the United States generally require that construction contracts be awarded on the basis of open competitive bidding, with award going to the lowest responsive and responsible bidder (F.A.C. 1985). This competitive bidding requirement makes it more difficult for public owners to involve construction contractors in the planning and design process. In fact, if one contractor were to conduct a design or some other such review during the design process, that contractor would probably have to be precluded from bidding on the job due to the potential conflict of interest. Failure to exclude that contractor would almost certainly result in a lawsuit by one or more unsuccessful bidders if the reviewing contractor bid on and was awarded the project.

Just because public sector owners face additional hurdles to gaining contractor input, however, does not mean that they cannot avail themselves of contractor expertise. It simply means that slightly different approaches from those used by private industry must be employed.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Study History

In an effort to tap construction contractor knowledge for the benefit of the project, the Galveston District of the US Army Corps of Engineers contracted with the Construction Industry Institute (CII) at the University of Texas at Austin to perform a constructability study of the Sargent Beach project.

As determined jointly by COE and CII representatives, the purposes of the constructability study were (CII 1993):

> a. Identification of planning, design, procurement, and field operations incident to the Sargent Beach project that could be improved through optimum use of construction knowledge and experience.
>
> b. Development of a study methodology that, if proven successful, would expand options available to public sector entities for exploitation of constructability techniques.

The scope of the study was developed jointly between CII and the COE, and is shown in Appendix C.

CII was well-qualified to undertake such a study due to (CII 1993):

a. Previous CII experience and research into constructability concepts in both the public and private sectors

b. CII's ability to draw upon member companies to participate in the study

c. The availability of faculty members, staff professionals, and graduate students at the University of Texas at Austin to participate in the study.

Upon agreeing to undertake the study, the CII leadership briefed selected UT faculty members and interested graduate students and formed a study team. The study team consisted of the CII Associate Director for Research in the capacity of study director, one post doctoral scholar whose function was to perform computer modeling of the project, and two US Army Corps of Engineers officer students.

At the time the CII study got underway, the COE had completed the following actions with regard to the Sargent Beach project (CII 1993):

a. The feasibility study was complete and the optimum solution (from an economic and environmental standpoint) was identified

b. The environmental impact statement was complete and approved

c. Congressional project authorization had been received

d. Conceptual design was complete, including physical model testing of the proposed design at the COE's Waterways Experiment Station at Vicksburg, Mississippi.

The rapid rate of shoreline erosion and the possibility of storm-induced damage, previously described in Chapter 2, combined to make the entire Sargent Beach project very time-sensitive. The COE was expediting their design efforts, and the constructability study was to be similarly expedited. The study schedule is shown in Appendix D.

3.2 Study Concept

The CII leadership's concept for conducting the constructability study was to convene a symposium of industry experts drawn from among CII member companies and to solicit their comments and recommendations concerning the proposed design and project management plan for the Sargent Beach project. These comments would then be analyzed and form the basis for the written report to be prepared by the study team and submitted to the COE.

3.3 Preparation Work

In preparation for this symposium, the study team members obtained copies of the proposed design, feasibility report, environmental impact statement, and related documents from the Galveston District and studied them to become thoroughly familiar with the project.

The study team used the study scope developed previously with the COE to develop a proposed report outline, and assigned responsibility for each area to a study team member. Such assignment of responsibility eliminated the problem of duplication of effort, and also ensured that all topics were covered.

The study director identified firms from the list of CII member companies that he thought had experience in heavy marine construction and so might be interested in participating in the symposium. The Galveston District provided the study director with the names of additional firms that the district had worked with and which were capable of doing this type of work, but which were not CII members. The study director made initial contact with the firms by telephone, and

extended formal invitations to those that had expressed interest in the concept. The invitation is shown in Appendix E.

Each study team member developed a list of questions pertaining to his particular area of responsibility that he wanted addressed at the constructability symposium. The study director, who was to act as the symposium facilitator, compiled these lists of questions into an outline for use as a guide to the discussion with the contractor representatives. This outline, or "Facilitator's Guidance Package," is shown in Appendix F.

In an effort to maximize the productive discussion at the symposium, the study director sent a read-ahead package to each contractor representative who would be attending the session. This package contained the following items:

a. Cover letter
b. Meeting agenda
c. Statement of meeting objectives
d. List of desired products to come out of the meeting
e. Excerpts of the project feasibility report describing the proposed design, including cross sections of the proposed structure

Copies of all of these items except the cover letter and feasibility report extracts are included as Appendices G through I of this thesis.

The purpose of the read-ahead package was to familiarize the attendees with the project as much as possible. Doing so, it was thought, would greatly reduce the amount of time needed to explain the project, and thereby maximize the time available to get contractor feedback.

The Galveston District debated whether or not it could legally send representatives to the constructability symposium. The concern was that since the symposium was a closed forum (as it was not publicly advertised and specific contractors had been invited to attend), COE attendance might violate provisions of the Federal Acquisition Regulations governing free and open competition. After consulting with legal counsel, the District concluded that it could legally send representatives. The District decided, however, that these representatives would attend primarily as observers, rather than as active participants in the discussion with the contractor representatives.

3.4 Constructability Symposium

The constructability symposium was held in the San Jacinto Room of the Houston Intercontinental Airport Marriott Hotel from 0800 - 1600 hours on Friday, February 12, 1993.

Representatives from seven construction companies were present. Including study team and COE personnel, total attendance was 24. The attendance breakdown is shown in Table 3.1.

Organization	# of Attendees
University of Texas/CII	6
Galveston District, COE	4
Contractor Representatives	14
TOTAL	24

Table 3.1 Constructability Symposium Attendees

The study director, in his capacity as symposium facilitator, began the meeting with personnel introductions, reviewed the meeting agenda and the list of hoped-for meeting products, and then provided a brief overview of the Sargent Beach project. He used overhead and 35mm slides to show cross sections and aerial photos provided by the COE to give the contractor representatives a better feel for the existing site conditions. As it was, several contractor representatives had worked on projects in the area and so were very familiar with the site and the conditions likely to be encountered.

Following the introductions and overview briefing, the facilitator moved into discussion of particular aspects of the project in accordance with the list of talking points put together beforehand. The general technique was for the facilitator to pose a question and then solicit comments from the contractor representatives. Because the meeting was not being electronically recorded, two study team members took notes, which were used to produce meeting minutes. These meeting minutes are included as Appendix J.

The two weeks following the meeting were devoted to developing the minutes of the symposium from the notes taken by the two recorders. Contractor comments were summarized, without attribution, with particular emphasis given to key points of agreement or disagreement. Copies of the minutes were sent to the COE as well as to all contractor representatives who attended.

3.5 Meetings With Designers and Site Visit

Because of the approach the COE took to the symposium (i.e. choosing to attend primarily as observers rather than as active participants in the discussion),

the study team found that most comments made at the symposium represented the contractors' perspective. Numerous issues, it was felt, needed to be explored from the owner's side as well. For this reason, the study team traveled to the Galveston District office on March 5, 1993 in order to meet with lead designers and key project management personnel to solicit their opinions on some of what the contractor representatives had proposed. The study team and the design personnel met in the district office conference room for approximately four hours. The study team then traveled to and visited the project site with the district's engineering project manager.

3.6 Data Analysis Methods

For most of the topics under study, several different courses of action were available to the COE. In some cases, the contractor representatives at the constructability symposium were in strong agreement as to which course of action they preferred. In other cases, there was no such consensus. The same was true for COE design and project management personnel.

For each course of action, the relative advantages and disadvantages were identified and subjectively weighed. Recommendations were then made as to which course of action the COE should adopt to maximize the chances of project success. Where these recommendations depended in part, at least, upon assumptions, these assumptions were identified so as permit evaluation of risks associated with the decisions.

3.7 Report Preparation

After each study team member completed data collection and analysis for his assigned areas of responsibility, he prepared a written report detailing the analysis, conclusions, and recommendations. These reports were then compiled into the overall report for presentation to the COE. A draft report was sent to the COE for review and comments. The study team reviewed the resulting comments and, in some cases, amended the report to reflect the additional information or revised design details. The final report was presented to the COE in August 1993. The table of contents of this final report is shown in Appendix K.

The study team briefed the contractor representatives who had attended the original constructability symposium on the team's findings and recommendations in Houston, TX in September 1993. The contractor representatives were also given copies of the constructability study at that time.

3.8 Constructability Symposium Questionnaire

A questionnaire, shown in Appendix L, was sent to all contractor representatives who had attended the constructability symposium along with their copies of the meeting minutes. The purpose of the survey was to:

1. learn more about what motivated the contractor representatives to attend
2. determine if they thought the symposium was a worthwhile effort
3. identify what they thought were the most important factors in making a successful symposium
4. identify areas that needed to be improved, and

5. gauge their willingness to attend a similar symposium for a different project.

Self-addressed, stamped envelopes were included with the questionnaires, which were to be anonymous. The results of this questionnaire are discussed in Section 8.7 of this thesis.

CHAPTER 4

RISK ASSESSMENT

4.1 Risk Allocation in General

Failure to clearly and equitably allocate risk will lead responsible contractors to try to protect themselves by including sizable contingencies in their bid prices, thus raising project cost. Contractors who fail to include such contingencies and who then face increased costs as a result of a risk gambled on and lost, will a) go bankrupt, b) attempt to "cut corners" to try to make up the lost money, or c) resort to claims and/or litigation (Hoens and Wallach 1989). All such options would have extremely negative effects on the project. It is clearly in the COE's interest to explicitly state who is expected to bear what risk.

In deciding upon risk allocation, the owner must realize that the use of contract clauses intended to prevent contractors from recovering for problems caused by the owner or those the owner is responsible for (such as the architect/engineer), only increases the adversarial nature of the construction process (Barrell et al 1988). Adversarial relationships almost inevitably hurt projects, and all parties stand to lose.

Because of its nature and location, the Sargent Beach project has several distinct, and in some cases, unique, risk areas associated with it. Among these risk areas are weather, transportation, materials production, materials placement, administrative delay, labor strife, design error or omission, and differing site conditions. Each of these risk areas are discussed in the succeeding sections.

4.2 Weather Emergency

4.2.1 General

The Sargent Beach project's location, on a virtual barrier island on the Gulf coast, devoid of significant natural or manmade cover, makes it highly vulnerable to the effects of weather.

Weather-related disruptions or damages could ensue from such things as:

- High winds
- Heavy rains
- Lightning
- Unusually high tides (due to storm surge, etc.)
- Tsunamis
- Tornadoes
- Tropical storms
- Hurricanes

According to the project Feasibility Report (COE 1992, GIWW Section 216 Study):

> Based on historical records, the Texas coast is subjected to a hurricane occurrence on the average of about once every 2 1/2 years. The average return frequency of hurricanes for any specific location along the coast is estimated to be once in 10 years... Hurricane characteristics vary from storm to storm, and a storm crossing the coast some distance away could still significantly affect the Sargent Beach area.

The contractor representatives said that, in the event of a hurricane or other severe storm, the contractor would suspend work and attempt to move all personnel

and equipment to the nearest safe harbor. Cranes and other heavy equipment would be loaded on barges and evacuated.

Given the project location and the historical weather data, it is at least fairly likely that a hurricane or similar storm will strike the project site sometime during its three-year construction phase. As a result, the contractor should be required to develop and submit to the COE a hurricane reaction plan detailing the steps the contractor would take in the event of a hurricane or similar weather threat.

The likelihood of a storm, coupled with the fact that the impact of such a storm could potentially be severe, makes clearly allocating the risk of such occurrences absolutely essential. Failure to clearly state in the contract documents who will be expected to bear what risk will almost certainly invite claims and recriminations should a storm occur. Properly allocating risk among the various parties according to the ability to bear such risk will help to minimize problems.

4.2.2 Risk Allocation Evaluation Criteria

In devising a risk allocation strategy concerning the threat of weather emergencies, three criteria should be used in evaluating proposed solutions. Those three evaluation criteria are:

a. Size of expected contractor contingencies and their impact on overall project cost

b. Contractor incentives to minimize project shutdowns and to prevent losses, and

c. Evacuation approval authority.

Contractors can be expected to include contingencies in their bids to attempt to protect themselves from the risks allocated to them. Contingencies drive up contractor bids, and the owner pays for them whether or not the event they are designed to cover actually occurs. While it is not in the owner's interest that a contractor gamble and include no contingencies, it is generally best if the owner strives to minimize contractor contingencies. In evaluating possible risk allocation schemes, the COE therefore should consider whether the proposed solution is likely to minimize contingencies, thus helping to keep costs down, or is likely to lead to the inclusion of sizable contingencies.

While most contractors are undoubtedly motivated by pride in workmanship, the challenge of completing a project according to a budget and schedule, and the satisfaction derived from building a tangible physical structure, money is arguably the most powerful motivator of all when it comes to influencing contractor actions. Any proposed risk sharing arrangement must provide the contractor with strong financial incentives to minimize weather-related shutdowns and prevent losses to material, equipment, or the work itself.

The third point that must be considered in evaluating proposed weather-related risk sharing provisions is the issue of who has the authority and responsibility for ordering and/or approving a shutdown due to an impending weather threat. The COE is not the best choice for having such authority as this would make the COE liable if a shutdown was ordered too late and the contractor's equipment, for example, was damaged as a result. Conversely, shutting down the project too early or unnecessarily would be expensive and could constitute disruption. The construction contractor, then, should be responsible for ordering a

project shutdown due to impending weather threats. Giving this authority and responsibility to the contractor, however, requires that the contractor have a strong incentive to absolutely minimize such shutdowns.

4.2.3 Cost Elements

For analysis purposes, six cost elements arising from weather emergencies will be considered:

Cost Element
Damage to Permanent Work
Damage to Temporary Facilities and Utilities
Damage to Materials
Damage to Equipment and Plant
Cost of Moving Equipment to a Safe Harbor (Labor/Materials/Equipment)
Cost of Overhead Expenses during Shutdown

Common sense dictates that, short of government negligence, the contractor should be responsible for damage to the contractor's equipment and plant. Insurance to cover such losses is available, and gives the contractor strong incentive to minimize any such losses. The contractor should be required to get insurance against weather-related equipment losses. All potential risk allocation schemes should make the contractor responsible for these losses.

4.2.4 Option 1: Standard Federal "Damage to Work" Clause

The standard federal "Damage to Work" clause [Special Clause 10: Damage to Work (Mar 1966) (CESWG-CT) (EFARS)] to be used on projects not involving use of a cofferdam provides that the contractor will be entitled to additional payment for repair of permanent work damaged by flood or earthquake (and can be amended to include damage due to hurricanes and tornadoes as well), but that the contractor is to bear the cost of repairs to temporary work and such items as utilities, materials, equipment and plant. It reads, in applicable part (COE 1992, "Master File"):

> The responsibility for damage to any part of the permanent work shall be as set forth in the CONTRACT CLAUSE entitled PERMITS AND RESPONSIBILITIES. However, if, in the judgment of the Contracting Officer, any part of the permanent work performed by the Contractor is damaged by flood or earthquake, which damage is not due to the failure of the Contractor to take reasonable precaution or to exercise sound engineering and construction practices in the conduct of the work, the Contractor will make the repairs as ordered by the Contracting Officer and full compensation for such repairs will be made at the applicable contract unit or lump sum prices as fixed and established in the contract... Except as provided herein, damage to all work (including temporary construction), utilities, materials, equipment and plant shall be repaired to the satisfaction of the Contracting Officer at the Contractor's expense regardless of the cause of such damage.

The clause seemingly anticipates situations such as Sargent Beach, where the threat of hurricanes is significant, and states:

> Whenever it appears that the Contractor may include a large contingency for damage to work caused by hurricane or tornado, the clause may be amended by deleting the phrase 'damaged by flood or

earthquake' and substituting 'damage by flood, earthquake, hurricane, or tornado'.

As written, this standard clause allocates responsibility to pay for the various cost elements as follows:

Cost Element	Responsibility
Damage to Permanent Work	Government
Damage to Temporary Facilities and Utilities	Contractor
Damage to Materials	Contractor
Damage to Equipment and Plant	Contractor
Cost of Moving Equipment to a Safe Harbor	Contractor
Cost of Overhead during a Shutdown	(Not Addressed)

Use of this clause as written would require the contractor to assess the risk of storm-related costs and include an appropriate contingency in the bid. This approach would have the advantage of giving the contractor a strong incentive to shut down the job only when truly necessary, since the contractor would be the one bearing the cost. This should reduce unnecessary shutdowns, thus helping keep the project on schedule. It also gives the contractor strong incentive to take action to minimize storm-related losses to materials or temporary facilities and utilities, since, again, the contractor has to pay for such losses. Under this approach, the government could clearly make the contractor responsible for making the call concerning weather-related shutdowns. Doing so limits COE liability as previously discussed.

The major disadvantage of this standard clause as written is that contractors can be expected to include substantial contingencies in their bids to cover the costs they are expected to bear, meaning that the COE will pay for these costs whether or not a hurricane or other such storm actually occurs. Contractors who fail to include sufficient contingency funds or who are faced with worse than expected weather could face severe financial hardship or bankruptcy. This would have severe consequences for the project, possibly including delays, pressure on the contractor to cut corners to make up for lost money, or contractor default. Because these contingencies are likely to be substantial, it is worth considering additional options that may result in lower contingencies while still satisfying the other criteria.

4.2.5 Option 2: Cost Reimbursement

This standard clause could be amended whereby the government pays a contractor's weather-related costs on a time and materials (i.e. cost-reimbursable) basis. The cost/responsibility matrix under such an approach would be as follows:

Cost Element	Responsibility
Damage to Permanent Work	Government
Damage to Temporary Facilities and Utilities	Government
Damage to Materials	Government
Damage to Equipment and Plant	Contractor
Cost of Moving Equipment to a Safe Harbor	Government
Cost of Overhead during a Shutdown	Government

The advantage of such an approach is that the COE pays only for those delays and disruptions that actually occur. The financial burden is clearly placed on the government, thus decreasing the likelihood that the contractor would be financially ruined as a result of storm losses. Contingencies would likely be virtually eliminated.

Such an approach would place an increased demand on the COE to monitor and verify the contractor's costs incurred as a result of weather-related shutdowns. This, in turn, increases the potential for disagreements concerning what is allowed and what is not, gives the contractor less incentive to minimize shutdowns, and requires development of guidelines concerning when a shutdown is permitted. This approach is judged to fail because it puts the burden of approving evacuation on the COE. If the COE disapproves a contractor's evacuation request, but the storm then results in damages to the project and/or the contractor's equipment, then the COE would likely be responsible for all related recovery costs.

4.2.6 Option 3: Weather Costs As Bid Items

A third option is to have contractors include weather-related shutdown costs (such as mob/demob, overhead, etc.) as line items in the bid, to be paid only if such a shutdown actually occurs. If such an approach is used, then the COE should set a minimum amount to ensure at least something is included for this item. The cost/responsibility matrix under this approach would be essentially the same as for the strictly cost-reimbursable approach:

Cost Element	Responsibility
Damage to Permanent Work	Government
Damage to Temporary Facilities and Utilities	Government
Damage to Materials	Government
Damage to Equipment and Plant	Contractor
Cost of Moving Equipment to a Safe Harbor	Government
Cost of Overhead during a Shutdown	Government

This approach provides a ready means for the COE to calculate the amount to be reimbursed to the contractor in the event of a weather-related shutdown. It also gives the contractor an incentive to price these items realistically, since if they are inflated, the contractor runs the risk of losing the bid. It also means the COE would pay only if a hurricane or similar storm occurs.

This approach, too, has drawbacks. Contractors may gamble that such storms will not occur, and therefore they may purposely underestimate the figure in order to win the bid. Doing so could cause the contractor financial problems if storms actually occur. This approach requires development of guidelines concerning when a shutdown is permitted, and still puts the burden of approving evacuation on the COE. If the COE disapproves a contractor's evacuation request, but the storm then results in damages to the project and/or the contractor's equipment, then the COE is likely responsible for all related recovery costs. This option is rejected on these grounds.

4.2.7 Option 4: Cost Sharing

An innovative approach worthy of serious consideration would be for the contractor and government to split storm-related costs (other than the cost of labor and contractor-owned equipment) on a 50-50 basis. The cost/responsibility matrix would be:

Cost Element	Responsibility
Damage to Permanent Work	Government
Damage to Temporary Facilities and Utilities	Shared
Damage to Materials	Shared
Damage to Equipment and Plant	Contractor
Cost of Moving Equipment to a Safe Harbor	Shared
Cost of Overhead during a Shutdown	Shared

Such an approach is more generous to the contractor than the standard federal "Damage to Work" clause, yet clearly gives the contractor a significant incentive to minimize weather-related evacuations of the job-site, since the contractor must pay half the cost of such actions. This should minimize delays and thus help to keep the project on schedule. Contingencies in bids should be significantly less (approximately by half) than they otherwise would be if the contractor was expected to bear all the risk. This approach also clearly gives the contractor significant incentive to take measures to safeguard materials, temporary facilities, and temporary utilities from loss or damage, since the contractor is responsible for half the cost of any such losses. While this approach will still impose some burden on the COE to verify contractor costs, there is significantly

less room for confusion or disagreement concerning what costs are and are not allowed than under a strictly "time and materials" system. This approach also eliminates the need for the COE to approve shutdowns and evacuations, thus virtually eliminating COE liability in this regard. The COE can take the approach that if the contractor thinks the threat is great enough and is willing to invest in an evacuation, then that is good enough for the COE. By taking itself out of the evacuation decision cycle in this way, the COE virtually eliminates the liability it may otherwise incur by approving or disapproving contractor evacuation requests. Cost sharing should help to reduce the threat of project and contractor financial failure arising from catastrophic storm-related losses.

This approach is not without disadvantages. For example, contractors will likely include some contingencies in their bids to cover the costs they should appropriately bear. This means the COE would end up paying these extra costs even if there were no storms. Some contractors may gamble that storms will not occur, and therefore may not include adequate contingencies to cover their share of storm-related costs. Such a contractor may then face financial difficulties or ruin, with severe consequences for the project, if that contractor is unable to finance a proportionate share of costs should a storm(s) occur.

This cost sharing option is judged to best meet the evaluation criteria, and is the recommended approach. As a result, the standard "Damage to Work" clause should be amended to provide for the following:

- The contractor will be entitled to additional payment for repairs to accepted permanent work.

- The contractor will be responsible for the cost of repairs to work in process.
- Documented costs (less labor and contractor-owned equipment) for repairs to temporary facilities and utilities, lost or damaged materials, moving equipment off the island or to a safe harbor, and overhead expenses during a storm-related shutdown will be split 50-50 between the COE and the contractor.
- Coverage will be provided for floods, earthquakes, hurricanes, tornadoes, tsunamis, or tropical storms.

Again, the cost of repairs to the contractor's equipment and plant should be at the contractor's expense.

To minimize the contractor's exposure to the risk of damage to work in process, and hence minimize the size of contractor contingencies, the "acceptance stations" should be made very short, on the order of, say, a couple of hundred feet, rather than 1/4 or 1/2 mile or more.

These provisions should be explicitly stated in the contract documents.

4.3 Transportation Failure

4.3.1 Water Transport

The project will be heavily dependent on water transport of equipment and materials. Water transport failure can result from:

a. Factors within the contractor's control, such as equipment breakdown or operator error, or

b. Factors outside the contractor's control, such as closure of the GIWW, a lock, or other waterway due to accident or weather.

The contractor should be expected to bear the risk for factors within the contractor's control. As a result, water transport delays due to contractor error should be treated as nonexcusable delays; in other words, the contractor will receive neither time extensions nor additional compensation.

Contractors should be entitled to time extensions for water transport delays beyond their control, but the issue of who should bear the financial risk for water transport delays beyond the contractor's control (other than those due to the owner's negligence), is worthy of in-depth consideration.

The contractor can be made responsible for the risk of water transport delays beyond the contractor's control by explicitly stating in the contract documents that the contractor will not be entitled to additional compensation to cover delay-related costs. This approach gives the contractor a strong financial incentive to maintain adequate stockpiles of materials on site to enable work to continue despite transportation disruptions. This should minimize the effects of transportation delays on the project schedule. A disadvantage of this approach is that it is likely to increase bids, as contractors can be expected to include a contingency to cover such risks, which the COE will pay whether or not delays actually occur. In addition, excessive transportation delays or inadequate contingencies could cause the contractor financial problems. These financial problems could, in turn, lead to increased pressure on the contractor to cut corners to save money or, perhaps, end in contractor default.

Making the contractor financially responsible for transportation delays means that the COE probably should not dictate the minimum size of materials stockpiles to be maintained on the project site, particularly if the standard "Damage to Work" clause (previously discussed in Section 4.2) is used and the contractor also has to bear the risk of damage to materials as well.

The opposite approach would be for the COE to accept financial responsibility for transportation delays beyond the contractor's control by agreeing to pay for delay-related costs. Failure to explicitly state in the contract documents that the contractor is not entitled to such additional compensation will probably mean the contractor will seek such additional compensation in the event such delays occur.

Having the COE bear the risk should eliminate any need for contractors to include contingencies to cover transportation delays beyond contractor control, thus lowering bids. The major disadvantage of this approach is that it reduces the incentive for the contractor to maintain adequate stockpiles and take other actions, such as innovative sequencing of the work, that would permit work to continue despite disruptions. This could mean larger impacts on the project schedule. If this approach is used, the COE would be fully justified in dictating to the contractor that certain minimum stockpiles be maintained on the project site, even if the contractor is forced to bear the risk of damage to materials.

Placing risk upon the contractor will, in almost all instances, result in higher bids, since prudent contractors will include contingencies to cover such risks. Yet, trying to maximize the latitude or flexibility given to a contractor to enable that contractor to organize the project to maximize efficiency (which should act to lower

bids), often requires putting additional risk upon the contractor. The same is often true of trying to "incentivize" a contractor. In this way, the risk allocation and maximum flexibility/incentive principles sometimes work against each other.

In choosing between two risk allocation options, as in this case, it is necessary to try to judge which is likely to have greater impact. In this instance, it seems that the most benefit to the project, in terms of minimizing schedule delays at the least cost, comes from giving the contractor as strong an incentive as possible to minimize delays due to any kind of water transport failure and to be able to work around such disruptions should they occur.

For this reason, it is recommended that the contract documents explicitly state that contractors will not be entitled to additional compensation for water transport delays, except those arising from the owner's negligence. The COE should not dictate minimum stockpile requirements; this decision should be left to the contractor's discretion.

The contractor can take some precautions to mitigate the impact of water transport failures. For example, the contractor should stockpile at least several days' worth of materials on site to enable work to continue despite a disruption in the flow of materials. Surge stockpiles should be expanded during the winter months as a hedge against weather-induced transportation delays in the spring.

4.3.2 Swing Bridge

The only land access to the project site is across the swing bridge operated by the Texas Department of Transportation at the end of FM 457. Given its nature, the swing bridge is subject to mechanical breakdown, rendering the project site

inaccessible by land, since the priority at this crossing site goes to GIWW traffic, not vehicular traffic. In the event of swing bridge failure, it is to be expected that, if anything, the bridge will be left in the "open" position, permitting GIWW traffic to continue but preventing vehicular traffic from reaching the island.

For this reason, the contractor should not rely on being able to use the swing bridge. This fact should be explicitly stated in the contract documents. Failure to do so could subject the COE to claims and/or the project to delays. Furthermore, the COE should be expressly exempted in the contract documents from claims arising from failure of the swing bridge.

The contractor should have an alternate plan in the event the swing bridge fails. For example, materials could be rerouted to barge terminals for shipment by water, and personnel and other high priority cargo could be ferried across the GIWW from a staging area adjacent to the project. The contractor should develop a contingency plan in the event the swing bridge is disabled. This contingency plan should include identifying and, possibly, leasing in advance, parking and/or marina facilities adjacent to the project site.

4.4 Production Failure

In this context, the term "production failure" refers to failures by materials suppliers or the general contractor (GC), if, for example, the GC is running an armor unit precasting plant.

Making the contractor (instead of the COE) responsible for procuring materials also makes the contractor liable for production failures by suppliers. The

COE may opt, however, to play at least some role in ensuring that materials suppliers are capable of producing the required quantities and quality.

The COE could play an active role in the procurement process by prequalifying suppliers, reviewing supplier financial records, or inspecting production facilities such as rock quarries or precast plants. The most important thing the COE could do in this regard would probably be to verify for the contractor that the proposed materials meet the required quality standards. Doing so, in advance and at the source, greatly reduces the chances that the project could be delayed due to materials problems. Furthermore, such an approach is consistent with a Total Quality Management philosophy, and might lower bids if contractors feel, for example, that preapproval of quarries or other suppliers reduces the risk of having materials rejected at the jobsite for failure to meet quality requirements.

Such an approach will, at least initially, require more work on the part of the COE. Another danger of this approach is that failure to rule on submittals or check suppliers within the allotted time could subject the COE to delay claims by the contractor.

The COE could, on the other hand, completely delegate responsibility for production to the contractor. While such an approach would entail less work for the COE, it greatly increases the chances of project disruption if materials problems are not discovered until materials delivery to the jobsite, and places more risk on the contractor, which might boost prices. By its reliance solely on inspection of the final product, this approach is not consistent with TQM philosophy.

While it entails some risk and more work, limited COE involvement in the production process will, ultimately, benefit both the contractor and the project, and is recommended.

Contractors should be required to submit the names of their proposed materials suppliers along with the bids. Following contract award, using either in-house personnel or an independent materials testing laboratory, the COE should verify the quality of the proposed stone supplies, the nature and quality of the equipment used to produce the stone, and the production records of the proposed supplier(s) to verify that production capacity is sufficient to support the proposed construction schedule.

The COE should review and approve the plans for the proposed casting plant, and COE inspectors should visit the plant once it is established or identified to check its set-up, operation, and quality control measures. Thereafter, COE inspectors should make periodic unannounced follow-up visits during actual production of the armor units and concrete sheet piles.

Contractors may want to incorporate an incentive clause or a liquidated damages clause into their materials purchase orders to help ensure timely deliveries. Contractors may also employ materials expediters to monitor supplier performance and help suppliers meet contractual obligations.

4.5 Placement Failure

Placement failure could result from:

- Equipment breakdown
- Operator error

- Poorly trained operators
- Insufficient numbers of equipment
- Improper equipment, or
- Incorrect or inappropriate procedures, either selected by the contractor or dictated by the owner through the use of procedural specifications.

Use of performance specifications on a fixed-price contract clearly puts the risk of placement failure on the contractor. Use of procedural specifications, conversely, would put a great deal of the risk on the party drafting the specifications.

The contractor representatives at the CII Constructability Symposium said that, in general, they preferred performance specifications as these afforded the contractor the most flexibility to make use of innovative procedures or equipment. In other words, the contractors expressed a willingness, in general, to accept the risk of placement failure placed upon them by performance specifications in exchange for increased latitude or flexibility.

Such was not the case, however, concerning the proposed sheet pile wall sections. The contractor representatives expressed serious reservations about the proposed design, and called for a prebid demonstration (as discussed in Section 5.5 of this report) to demonstrate the viability of the proposed design if performance specifications were going to be used for this portion of the work. The contractor representatives said a demonstration would not be necessary, for them, anyway, if procedural specifications were employed.

It is in the COE's interest to maximize the use of performance specifications, as this will minimize the COE's risk due to placement failure and afford the contractor maximum flexibility for use of innovative methods. However, performance specifications for the sheet pile wall sections should be used only if a prebid demonstration is conducted, and the proposed design proves satisfactory. If not, then procedural specifications should be used.

4.6 Administrative Impediment

As the owner, the COE has the duty to provide the contractor with adequate access to the site such that the contractor can perform the work. Various administrative impediments such as environmental challenges, failure to acquire the necessary real estate, political interference, or budgetary limitations (other than those arising from the contractor's negligence) can be said to constitute failure to provide adequate site access. The COE should rightfully bear the risk of any and all such delays except those arising due to contractor negligence. This will serve as a powerful incentive to the COE to work out as many such problems as possible prior to letting the contract, and should also serve to lower bids if contractors know they will be adequately compensated for such delays.

The standard federal clauses concerning liability for delays due to administrative impediments have been reviewed and are judged adequate.

The COE should include a "Termination For Convenience" clause in the contract to allow the COE to terminate the contract and cut its losses should the project be delayed or interrupted for an inordinate amount of time.

4.7 Labor Strife

Labor strife is traditionally regarded as excusable, noncompensible delay, unless it is caused by a party's bad faith or mismanagement. This should be explicitly stated in the contract documents.

4.8 Design Error or Omission

As both the owner and the engineer, the COE has the duty to provide the contractor with plans and specifications adequate to do the job. Some owners have attempted to shift the risk associated with design errors or omissions to the contractor by using contract clauses making the contractor liable for design errors or omissions not detected during the bid phase. Use of such risk-shifting provisions is both unfair and unwise.

The normal bid period is not long enough to enable contractors to conduct thorough reviews of proposed designs. It is also debatable if contractors are even qualified to conduct such reviews, since contractors may or may not have experience in designing such structures.

The COE, with its experience in coastal engineering and access to such resources as the Waterways Experiment Station, is clearly in the best position to ensure an adequate design, and so should bear the risk of providing adequate plans and specifications. Contractors should not be made responsible for design errors or omissions.

4.9 Differing Site Conditions

The standard federal Differing Site Condition (DSC) clause is generally regarded by contractors as fair and equitable, provided it is administered in a fair and equitable manner by the on-site owner representatives, and should be used on this project.

A potentially more serious problem is the possibility that the remaining beach between the proposed revetment and the Gulf could erode. This would constitute a major change in the site conditions.

The rate of shoreline erosion in the Sargent Beach area is variable. In view of this, the project Feasibility Report states: "Regardless of the timing of the construction start, the most vulnerable areas, such as McCabe's Cut and Choctow Lake, should be constructed first" (COE 1992, GIWW Section 216 Study).

The current design, particularly with regard to the rolled clay sections, is predicated upon the assumption that revetment construction will not occur in the surf zone, i.e. that the Gulf will not have eroded the shoreline as far back as the proposed structure. Barring any major storms between now and when bids are taken, that is also the basis upon which bids will be made. In other words, the contractors will assume they will not be working in the surf. That this is a valid assumption should be explicitly stated in the contract documents.

Given the present rate of erosion, this appears to be a valid assumption by both the COE and the contractors. However, the COE should at least consider the possibility that this will not be the case. It is possible that the erosion rate will increase or a storm or series of storms will strike such that the beach erodes and the contractor must work in the surf. This would most likely occur only in a few

scattered locations, and probably not along the entire eight-mile length of the structure. The contractor would most certainly claim a Differing Site Condition and look to the COE to adjust the contract accordingly. Such a scenario has many implications and is worthy of consideration beforehand.

The COE must consider if the proposed design can reasonably be built in the surf, perhaps using cofferdams or other such structures to provide some degree of protection from wave action. If the conclusion is that the present design could not be built in the surf, then the COE should develop an alternate design as a contingency plan and put it "on the shelf." Development of this alternate design should include model testing at the Waterways Experiment Station. Developing such an alternate design in advance, while it will cost money, would undoubtedly save much time, trouble, and expense over trying to do it in an emergency should a storm strike.

Even if the proposed design would still be valid, working in the surf would certainly be more difficult for the contractor, and would require adjusting the contract to reflect this. Such adjustments could be made using change orders.

To lessen the chances of a breakthrough or that rapid erosion would erode the existing beach back to the location of the proposed revetment, thus perhaps requiring use of an alternate design, the COE should consider dictating to the contractor in the contract documents that certain highly vulnerable sections (i.e. those subject to faster erosion or most susceptible to a breakthrough) be constructed first. An appropriate mechanism for achieving this would be to use contractually imposed milestone dates for completion of certain designated sections such as McCabe's Cut and Choctow Lake.

CHAPTER 5

PROJECT CONTROLS

5.1 Government Furnished Facilities, Materials, or Equipment

5.1.1 General

Traditionally, owners have furnished facilities, materials, or equipment under such circumstances as:

- Long lead time items
- Single source items
- Where certain information pertaining to the items (such as size, weight, power requirements, etc.) is needed to complete detailed design
- Where the owner, because of the volume of purchases, can get a better price, or
- To ensure the use of a particular make or model.

If an item does not fall into at least one of these categories, then owners are generally better off letting the contractor supply it. While supplying an item affords the owner greater control, it also entails greater risk if problems arise pertaining to that item. As a general rule, then, owner-furnished items should be kept to a minimum.

5.1.2 Mooring Facilities

The project site's location adjacent to the GIWW, the extremely large volume of materials, and the limited land access to the project site combine to make water transport of the large quantities of material and equipment required the only

viable option. The contractor representatives in attendance at the CII Constructability Symposium concurred with this assessment.

Assuming that the so-called "wet method" of construction (cutting access channels from the GIWW in to the interior of the island, using dredges to excavate, and putting materials directly in place from barges floated in) is ruled out, mooring facilities of some sort would be required for construction of the revetment. Furthermore, the COE desires mooring facilities on the island to facilitate maintenance of the revetment throughout its projected 50-year life.

No existing mooring facilities are suitable for equipment or material off-loading in the vicinity of the project site, the banks of the GIWW are unstable enough, and concern about additional bank erosion is great enough to require some type of engineered mooring facility to be built to facilitate equipment and material off-loading.

The majority of contractor representatives at the CII Constructability Symposium expressed a preference that the COE issue a separate contract for construction of these mooring facilities such that they be completed prior to awarding the revetment construction contract(s).

There appears to be sufficient time to permit letting a separate contract to build mooring facilities and to have these mooring facilities complete prior to awarding the main revetment contract.

The contractor representatives' suggestion to have government-furnished mooring facilities has a significant advantage in that it should speed up the overall project by essentially fast-tracking it; in other words, the overall project schedule

can be accelerated by putting the mooring facility contract out for bid while the revetment is still under design and while real estate is being acquired.

A disadvantage is the possible higher overall cost, since the COE would, in essence, be paying for two mobilizations, additional overhead, etc. Also, failure to complete the mooring facilities prior to the start of revetment construction would delay such construction and probably subject the COE to claims by the revetment construction contractor. It would also require more work for the COE due to the need to let and administer an additional contract.

If the revetment construction contractor were to furnish the mooring facilities, they could be "tailor-made" (within the limits of the applicable specifications, if any) to meet requirements created by particular equipment, methods, or techniques. This should enable the contractor to maximize efficiency, resulting in lower costs to the owner and/or higher profits for the contractor. It could result in lower overall costs, since the COE would only be paying for one mobilization, and would largely eliminate the mooring facilities as a source of potential claims from the revetment construction contractor for such things as delayed completion, faulty construction, etc. There would also be less work for the COE since it would not have to award a separate contract.

On the negative side, this option will probably result in a later start of actual revetment construction due to the inability to fast-track the project, since the revetment construction contractor would have to build the mooring facilities before beginning any substantial work on the revetment.

Having the revetment construction contractor build the mooring facilities may or may not result in a cost savings, but will almost certainly mean a later start

on construction of the actual revetment itself. Because of the time-sensitive nature of this project, this must be the overriding factor. Therefore, a separate contract should be let for construction of mooring facilities such that they are completed prior to awarding the revetment construction contract.

Good design and project management by the COE should prevent the mooring facilities from being a source of claims by the revetment contractor if they are, in fact, constructed under separate contract.

As mentioned above, the design of the mooring facilities will potentially have a large impact on the efficiency of the revetment construction contractor in off-loading the equipment and materials. A good design should enhance efficiency and result in lower bids, while a poor design will inhibit efficiency and yield higher bids. Because all contractors are likely to have at least slightly different ideas as to how to best organize equipment and material unloading, the COE mooring facilities design, if they are to be constructed under separate contract, should not be such that it forces a contractor into one configuration or setup. The scope of work of such a separate mooring facilities contract should include dredging, bulkheads, minimal hardstand, and barge tie-offs.

The revetment construction contractor should be permitted to make additions or changes, subject to COE approval and at the contractor's expense, to the mooring facilities to maximize productivity in off-loading operations. This should be explicitly stated in the contract documents.

Contractor input into the proposed mooring facility design is desirable, not only to enhance the constructability of the mooring facilities in and of themselves, but also to ensure that the design meets the basic needs of the potential revetment

construction contractors so as to enhance, not inhibit, productivity. Input into the proposed mooring facility design should be sought, therefore, from both potential revetment construction contractors and potential mooring facility construction contractors.

The contract documents should give the revetment construction contractor the express responsibility of repairing and maintaining the mooring facilities throughout the life of the contract. The revetment construction contractor should be expected to turn the mooring facilities back over to the COE in the same condition, less normal wear and tear and any approved changes, as when the contractor received them.

Given the need to maintain and repair the structure throughout its projected 50-year life, at least one of the mooring facilities should be designed and constructed to support this. A life cycle cost analysis should be made to determine the optimum design life of this facility.

5.1.3 Armor Units

The consensus of contractor representatives at the CII Constructability Symposium was that the contractor, not the owner, should be responsible for supplying the estimated 68,000 armor units required for the project.

Contractor representatives felt that, assuming precast blocks were to be used, the casting yard would not be set up on the island, but rather would be on the mainland close to the material sources. No consensus was reached, however, as to whether the revetment construction contractor would set up and operate this casting yard or contract with a supplier. Innovative production and handling of the armor

units, either by a supplier, the contractor, or both, will yield a significant advantage to a contractor and should be encouraged.

There are a sufficient number of existing precast concrete yards capable of supplying the required blocks in order to generate sufficient competition for the work, should the revetment construction contractor elect to contract with a supplier for the armor units. In other words, the blocks would not be "sole-sourced", nor do they constitute long lead time items.

Having the government furnish the armor units would afford the COE greater control over the source of armor units, but would entail more work for the COE in terms of letting and administering the contract. Such action also could subject the COE to claims if there were problems with government-furnished blocks, such as late delivery or poor quality.

Having the contractor furnish the armor units affords the contractor maximum flexibility in organizing the project, makes the contractor solely responsible, means one less contract for the COE to prepare and administer, and removes the COE as a potential target for claims arising from "owner-furnished materials."

A recurring theme from contractor representatives at the CII Constructability Symposium was the call to give the contractor maximum flexibility whenever possible. Such flexibility, while requiring clearly defined quality standards, rewards innovative contractors and, ultimately, gives the government a lower price.

None of the traditional circumstances justifying owner-furnished items appears to apply in the case of the armor units. The revetment construction

contractor therefore should be responsible for supplying the armor units, not the government.

5.1.4 Haul Road

For analysis purposes, it is assumed that the location of any haul roads would be left to the contractor's discretion, provided those roads remained within the bounds of the construction right of way, if the contractor were furnishing those haul roads.

There was no call by contractor representatives at the CII Constructability Symposium for the haul road to be "owner-furnished."

Because of the poor quality of soil on the island, at least some material for the haul roads will probably come from off-site. This material will be brought in by barge, owing to the limited road access to the site, meaning that the haul roads could not be completed until after the mooring facilities are in place.

No advantages have been identified to having the government furnish any haul roads. One disadvantage, however, is that doing so may delay start of actual revetment construction owing to the need to wait for mooring facilities to be done before fill material can be brought in. Problems with the haul road may subject the COE to claims from the revetment construction contractor. It also would mean more work for the COE due to the need to let and administer an additional contract, and may increase total project costs.

Having the revetment construction contractor furnish haul roads affords the contractor maximum flexibility in terms of scheduling work and ensuring the haul road best supports revetment construction operations. This approach also should

result in a shorter overall project duration, and would largely remove the haul road as a source of potential claims as it would not be an owner-furnished item. There would also be less work for the COE as there is one less contract to let and administer. No disadvantages to this approach were identified.

The haul road will be an important element in the contractor's project execution plan. For this reason, the COE should afford the contractor maximum flexibility and not dictate the location of the haul road. COE-dictated design criteria should be kept to a minimum.

The revetment construction contractor should be responsible for constructing any and all haul roads required for revetment work. The haul road should be left in place following the completion of revetment construction to support future maintenance and repair operations.

5.1.5 Staging Areas

There was no call on the part of contractor representatives at the CII Constructability Symposium for the government to furnish staging areas (aside from the mooring facilities), either on the island or the mainland.

Contractor representatives felt the proposed 300-foot right of way (ROW) was wide enough to permit materials storage within its limits; no additional requirements were identified.

Contractor representatives expressed a desire to select their own materials storage locations rather than have them dictated by the COE.

Most of the materials and equipment used on the project are expected to be barged to the site from suppliers outside the immediate vicinity, thus greatly

reducing or eliminating the need for staging areas on the mainland side of the GIWW.

Because this project will be competitively bid, it is impossible for the COE to identify in advance from what port the contractor will stage equipment and materials for movement to the project site.

The COE does not require or desire permanent staging areas (other than those associated with the mooring facilities) to support future operation and maintenance activities.

If the government were to furnish staging areas, they could probably secure a better price than if the contractor were trying to lease under a deadline to get started with the work. This approach could also save time by having the arrangements in place at the time of revetment contract award. The disadvantage is that it would cost money whether or not the winning contractor actually needed or wanted use of the staging areas.

Requiring the contractor to arrange for staging areas, if any, affords the contractor maximum flexibility in organizing the project, and saves money if the contractor does not need additional staging areas. The disadvantages are that it could delay actual start of revetment construction due to the need for the contractor to secure use of and establish the area, and could cost more money than if the COE leased areas prior to contract award.

If there was a clear-cut need for staging areas (aside from those immediately adjacent to the mooring facilities), then it probably would be advantageous for the government to secure use of such areas prior to letting the revetment construction contract. Since there is no clear-cut need and the contractor representatives prefer to

make any such arrangements themselves, it is probably not worth the COE's time, effort, or expense.

The only staging areas that the COE should furnish are those immediately adjacent to the mooring facilities. Any other staging areas should be left to the contractor's discretion.

5.2 Number of Contracts For Revetment Construction

Of the seven firms represented at the CII Constructability Symposium for the Sargent Beach project, none voiced opposition to using a single contract for this project. The contractor representatives also said that if multiple contracts were used, all contractors who bid on the first contract would probably also bid on subsequent contracts. If two or more contracts were to be used and they were to be bid at separate times, they said, the contractor who won the first contract would be at a significant advantage with regard to bidding subsequent contracts.

Use of multiple contractors on this project is not a stated social goal of the COE, thus making use of one contract an available option.

Using one contract for revetment construction would mean less work for the COE, in that it would need to let and administer only one contract. It eliminates the problem of having contractors competing for casting yards and rock suppliers, eliminates contractor interference as a source of conflict and potential claims, and eliminates the requirement for the COE to schedule and integrate the work of multiple contractors. It could result in lower total project cost due to the greater economies of scale possible.

The disadvantage of this approach is that it could result in fewer bidders since some smaller contractors may be precluded from bidding if the scope of the job was beyond their capabilities.

Use of two contracts could increase the number of bidders on the project by enabling more small contractors to bid. If two separate contractors are awarded the contracts, that could yield public relations benefits for the district as this may be seen as "sharing the wealth." It could also increase the chances that the project would meet stated DBE participation goals.

Use of two contracts, however, would clearly increase the amount of work required of COE personnel in terms of contract preparation and administration. It could cause contractors to compete for casting yards, material suppliers, etc., which could drive up overall project cost. It would require the COE to manage the interface between the two contractors in terms of physically integrating the revetment work faces into a single structure, and would increase the potential for interference claims, perhaps against the other contractor or against the COE for alleged failure to adequately coordinate or schedule the work of the contractors.

Judging by the attendance at the CII Constructability Symposium, there is enough interest in the project on the part of large contractors to generate sufficient competition to ensure competitive bids. Small firms that did not have the capability to tackle the entire project by themselves could form joint ventures in order to bid on the project if it was to be bid as a single large contract.

Since use of multiple construction contractors is not a stated social goal of the COE, the advantages of using a single contract appear to far outweigh the disadvantages. Therefore, a single construction contract should be let for

construction of the revetment and related work, less the mooring facilities as discussed in Section 5.1.2.

5.3 Partnering

5.3.1 Use of Partnering on the Project

A research study conducted by a COE officer student at the University of Texas at Austin indicated that COE projects on which partnering was employed outperformed non-partnered projects in the following areas:

a. Lower cost growth

b. Smaller schedule growth

c. Lower cost of change orders

d. Fewer claims

e. Greater value engineering savings

The study revealed the following in a comparison of project performance (Weston 1992):

Criteria	Partnered Projects	Non-Partnered Projects
a. Avg Cost Growth	3.86%	12.98%
b. Avg Schedule Growth	9.08%	16.63%
c. Avg Cost of C.O.'s	3.90%	11.06%
d. Avg Claims Cost	0.67%	4.86%
e. Avg V.E. Savings	0.73%	0.05%

No areas were identified in which partnered projects performed worse than non-partnered projects. Subjective data collected by the researcher revealed that none of the contractor or COE project managers interviewed were dissatisfied with the partnering process, although all stressed the need for maintaining the partnering relationship throughout the life of the project through the use of follow-up meetings and workshops. While the Galveston District was not among those districts whose projects were examined in the course of the research study, there is reason to believe that the same benefits could accrue with a similar approach.

The COE's official position on partnering is that it should be promoted and practiced on all construction contracts, as well as in all other relationships, internal and external (Hatch 1992). The COE policy is to offer to partner, but contractor participation is not mandatory. Partnering costs are split between the COE and the contractor. Outside facilitators are typically employed to lead the partnering sessions.

The Galveston District is in the process of implementing a partnering program, but has not yet applied it to any projects.

All of the contractor representatives in attendance at the CII Constructability Symposium who had partnering experience, be it with the COE or other owners, said it was a worthwhile effort. No obstacles to a successful partnering effort on this project were identified.

The Galveston District is in the process of implementing a Total Quality Management (TQM) philosophy in district operations. Partnering with customers and suppliers is an integral part of the TQM process.

Partnering on the Sargent Beach project would enable the Galveston District to comply with COE guidance concerning partnering, and should complement the Galveston District's TQM efforts by providing a means of bringing the contractor into the district's quality process.

Most importantly, partnering should result in a superior project in terms of:

- Lower cost growth
- Smaller schedule growth
- Fewer claims
- Greater value engineering savings
- Increased personal satisfaction for district personnel working on the job
- Higher project quality

There are costs associated with partnering. It would require money for partnering expenses, and a fairly substantial time investment by key district and project leaders to participate in teambuilding sessions and other partnering efforts. Much like TQM, partnering may require a change in mindset on the part of contractor and district personnel.

Not using partnering would save the money to be spent on partnering efforts, and place less up-front demands on the time of key district and project personnel. Excluding partnering also would eliminate the need for any attitude changes.

Failure to use partnering, however, may place the Galveston District at odds with official COE policy concerning partnering, and, most importantly, would deny the project the benefits that come from partnering. A more adversarial relationship

with the contractor may ensue than might otherwise exist, which could translate into more claims and greater effort required to ensure that quality standards are met. It would also be contrary to TQM philosophy, and could hurt the district's TQM implementation effort.

The general consensus within the industry right now, as evidenced from remarks by the contractor representatives at the CII Constructability Symposium, is that partnering is a positive development in attenuating the traditional adversarial relationship between owners and contractors, which is the root cause of so many of the problems in the industry today. The perceived benefits of partnering appear to be born out by the results of the UT-Austin research into partnering on COE projects.

While partnering will place greater initial demands on the time of key district and project leaders, it will almost certainly save them even more time in terms of fewer claims and other attendant problems.

The Galveston District should therefore include in the bid documents an offer to enter into a partnering effort with the winning contractor.

Assuming the contractor agrees to partner, periodic follow-up workshops should be conducted at regular intervals in order to maintain the spirit of partnering throughout the life of the project. Outside facilitators should be employed to conduct initial and follow-up partnering sessions.

5.3.2 Partnering Participants

Assuming the Galveston District chooses to use partnering on the Sargent Beach project, it is worth considering if any parties beyond the contractor should be involved in the partnering effort.

As previously stated, it is the policy of the U.S. Army COE to promote and practice partnering on all construction contracts, as well as in all other relationships, both internal and external. Examples of parties other than contractors with whom partnering is to be promoted include customers, cost sharing partners, and architect/engineers (Hatch 1992).

The University of Texas at Austin research project into partnering on COE projects revealed that of 31 districts using partnering, 28 were partnering solely with contractors, one solely with other agencies, and two with both contractors and other agencies. No districts were currently partnering with design firms (Weston 1992).

While the Galveston District is in the process of implementing a partnering program, it has not yet applied it to any projects. It is not unreasonable to assume that, by the time the Sargent Beach project begins, the Galveston District will be using partnering on several ongoing, if not yet completed, projects. As a result, the district should have at least some experience with partnering.

Because of the location of the project site, particularly its proximity to and reliance on the GIWW and its proximity to the San Bernard National Wildlife Refuge, both the COE and the contractor can expect to have to closely interact with numerous other local, state, and federal agencies to ensure project success.

Because most if not all of the equipment and materials used on the project site will be barged in, the contractor will be heavily dependent on the GIWW. Anything that can be done to alleviate contractor problems with shipping should translate into lower costs, fewer claims, and fewer delays.

In the present regulatory environment, and especially considering the project's location, environmental concerns have the potential for significant impact on the project. Preventing such problems is critical to project success and is often simply a matter of communication among the parties involved.

The Texas Department of Transportation is the local sponsor for the project. As such, it is the lead State agency with regard to the project (COE 1992, GIWW Section 216 Study).

Limiting the partnering effort to the COE and the construction contractor keeps the Galveston District within the mainstream of other COE districts concerning partnering efforts. Given the relatively limited experience the Galveston District has with partnering, it also eliminates the danger that the partnering effort could fail due to trying to "do too much too soon" by trying to include too many players. It should keep partnering costs down.

Failure to include a key outside player in the partnering effort, however, could prove detrimental to project success if a problem with that player later arises. Limiting the effort to the COE and the construction contractor also precludes the Galveston District from taking a lead position among other COE districts with regard to partnering. It may result in higher project costs if contractors feel compelled to boost contingencies to cover potential problems arising from areas such as environmental, permitting, or transportation.

Expanding the partnering effort to include other key agencies enables the Galveston District to take a lead position vis-a-vis other districts in the field of partnering. Inclusion of outside agencies that are expected to have a potential major impact on project success should translate into lower total project costs owing to lower contingencies in bids and fewer claims. A "united front" by key agencies having jurisdiction over the project should reduce the ability of opposition groups to hinder or otherwise challenge the project.

The disadvantages of an expanded partnering effort are that it will increase partnering costs and may threaten the success of the partnering effort if too many players are involved. Too many widely divergent interests may prevent reaching consensus on key issues.

The fact that expansion of the partnering effort to include parties other than the contractor would put the Galveston District in the forefront of COE partnering efforts, in and of itself, is insufficient grounds for doing so. While the potential benefits are substantial, so are the risks.

The contractor representatives at the CII Constructability Symposium expressed serious reservations about several aspects of the proposed design, most notably the concrete sheet pile sections, which they rated as having moderate potential for generating claims. Several expressly called for inclusion of the designers in the partnering effort. While extensive efforts are being made by the designers to address the contractors' concerns, it is unlikely that they will be able to completely eliminate all doubts. Contractor concerns translate almost directly into higher contingencies and, ultimately, higher total project costs. Anything the COE can do to alleviate or mitigate contractor concerns should result in lower costs.

Involving project designers, to include Kenneth Balk and Associates, the private consulting engineering firm performing the detailed design for the sheet pile wall, in the partnering effort should help to lower contractor concerns and, hence, prices. The savings from having the designers participate in partnering efforts will probably not be in the form of markedly lower bid prices, but rather in the form of reduced claims.

The key project designers, both in-house district personnel and Kenneth Balk and Associates, should therefore be included in the partnering effort. This fact should be expressly stated in the contract documents. Under the proposed COE reorganization (presently on hold), the Galveston District design section would be moved to and consolidated with the Ft. Worth District design section. This should not deter the COE designers from participating in the partnering effort.

The COE should also consider including two or three other key agencies in the partnering effort. This partnering effort should begin in the design phase so that the partners' concerns can be incorporated into the design and project planning. The partners would continue into the construction phase, providing the contractor agreed.

Organizations that should be considered for involvement in the partnering effort include:

- Texas Department of Transportation
- U.S. Environmental Protection Agency
- San Bernard National Wildlife Refuge/U.S. Fish and Wildlife Service
- U.S. Coast Guard
- Texas Water Commission

- Matagorda County
- Local Homeowners Associations, if any.

5.4 Dispute Resolution

The construction industry is to the point where it is widely recognized that a better method than litigation of resolving disputes is required; not employing some type of Alternative Dispute Resolution (ADR) should not be considered as a viable option.

COE policy calls for the use of ADR whenever possible to reduce the cost of settling claims via litigation (Hatch 1990). ADR is non-binding; litigation is an available option, though it is generally to be avoided except as a last resort. The Galveston District does not have a stated preference for the type of Alternative Dispute Resolution employed; there is a willingness to use whatever seems best suited to the particular situation. The only dispute resolution method not available is binding arbitration; all other methods are at least options.

The contractor representatives attending the CII Constructability Symposium rated the overall claims potential of this project as low to moderate, based on what they had been told so far. The factors that they felt would ultimately determine the likelihood of claims included:

- The reasonableness of the project quality specifications
- The length of the "acceptance stations"
- The design and specifications for the concrete sheet pile sections.

Several of the contractor representatives voiced a preference for mediation, saying it was relatively inexpensive and not too time-consuming. The contractor

representatives stated that since the expected method of resolving disputes is one consideration in putting together a bid, the planned or available technique(s) should be stated in the bid documents.

The parties involved in a dispute should, of course, first attempt to negotiate a settlement, and only resort to ADR if they are unable to reach agreement.

For purposes of this analysis, three methods of ADR will be considered:

- Mediation
- Dispute Review Board (DRB)
- Arbitration

One advantage of mediation is that it only costs money if a dispute actually arises. It is also less expensive than arbitration or litigation. The disadvantages of mediation are that it may take longer to resolve a dispute than a Dispute Review Board, and is less suited to rulings concerning interpretations of plans, specifications, and industry standards than a DRB.

Dispute Review Boards are in place and monitoring the project from the beginning, thus reducing the "ramp-up" time required to settle a dispute since the members are already familiar with the project. The board is typically comprised of industry experts chosen for their knowledge of a particular field of construction. This fact may tend to prevent frivolous claims, since the experts can be expected to "see through" such claims (Shanley 1989). In other words, parties may pursue only those claims they can substantiate. DRBs are well suited to ruling on interpretations of plans, specifications, and industry standards owing to the members' experience, and are also well suited to making timely decisions, allowing the parties to "get on with the job" rather than having a dispute linger, awaiting mediation or arbitration.

Lingering disputes foster adversarial relationships and should be avoided at virtually all costs.

A disadvantage of Dispute Review Boards is that they cost money, even if there are no disputes on the project. They may also contribute to "buck passing" by owner or contractor project managers, who, rather than make a decision, may take the "let the DRB decide" approach.

Like mediation, arbitration only costs money if a dispute actually arises. The disadvantages are that it is relatively expensive and time consuming, and is not conducive to timely decisions. It is also not well suited to rulings concerning interpretations of plans, specifications, or industry standards.

While arbitration once seemed to hold promise, it has become increasingly structured to the point where it is not much better than litigation.

The two remaining options, then, would seem to be mediation or a Dispute Review Board. Mediation is a tried and true technique with many advantages; mediation, as a minimum, should be used on the project.

The only remaining question, then, is if this project is suitable for a DRB. Dispute Review Boards got their start in the tunneling industry; the fact that the work is underground and involves many unknowns and unknowables until one actually "digs in" tends to make for disputes and disagreements. Having a board comprised of members knowledgeable in the field and familiar with a particular project has been shown to facilitate dispute resolution and, it would seem, also helps to prevent disputes from arising in the first place (Coffee 1988). By extension, DRBs appear to be proving themselves suitable on almost any project with a large number of "unknowns and unknowables," such as underground work

and, increasingly, complex renovations. While not a tunnel, the Sargent Beach project involves substantial excavation and project success will hinge to a large degree on how closely the design matches the actual ground conditions encountered. It would seem to fall within the category of projects that would benefit from a DRB.

A Dispute Review Board should therefore be employed on the project. It should have three members, one appointed by the owner, one by the contractor, and a neutral member agreed upon by the other two members.

Should the recommendation to use a Dispute Review Board not be accepted, however, mediation should be used if required.

Whatever methods of Alternative Dispute Resolution are selected, the methods to be employed should be explicitly stated in the contract documents.

5.5 Prebid Demonstrations

5.5.1 Pile Driving

Of the revetment's eight-mile length, about 4000 feet, or approximately 10%, will be sheet pile wall. The more information the COE can provide to the contractors concerning what they can expect to encounter in building these walls, the better the bids should be. High quality, well-founded bids are a key ingredient in overall project success.

A pile driving demonstration is one means of providing contractors with such information, and should be considered. The COE has used this approach before, as test piles were driven prior to letting the contract for the 1970 Texas City Dike project (Tomlinson 1993, "Memorandum"). For purposes of analysis, it is

assumed that any demonstrations would be done only once, either during the design phase or the bidding phase, but not both.

The Engineering Appendix to the project Feasibility Report raises the issue of the need for pre-drilling the piles, stating "It is anticipated that it may be necessary to drill pilot holes for the 16in x 40ft precast concrete sheet pile" (COE 1992, GIWW Section 216 Study).

As mentioned in the previous section, the contractor representatives at the CII Constructability Symposium expressed serious doubts about the design for the concrete sheet pile wall. Several contractor representatives held the opinion that jetting the piles would be required; this would have an impact on the design, as tiebacks would then be required. The issue of whether the piles need to be pre-drilled could potentially have a significant impact on the cost to install the piles.

A test pile demonstration will either confirm the contractors' fears, in which case the designers will have to take corrective action, or allay them, which should yield lower bids.

The general consensus of the contractor representatives was that a prebid demonstration of pile driving would be helpful to clarify such issues, particularly if performance specifications were going to be used. The contractor representatives felt such a demonstration would not be needed if procedural specifications were used. From the COE's perspective, however, a demonstration is perhaps even more vital if procedural specifications are to be used, since use of procedural specifications places greater risk on the party drafting the specifications than does use of performance specifications.

One option would be to conduct a pile driving demonstration during the design phase of the project. This would enable the COE to validate, to a great extent, the feasibility of the proposed design, and afford time to amend the design if problems were discovered. This approach would also enable the COE to validate the proposed pile driving specifications, which is especially critical if procedural specifications are being used. It would provide valuable information to potential bidders, resulting in more accurate bids with less potential for claims and related problems.

The disadvantages of performing the demonstration during the design stage, as opposed to the bidding stage, are that (1) it would require effort on the part of the COE to publicize the demonstration in order to attract a large number of potential bidders, and (2) it would require the COE to capture the results of the demonstration (perhaps using videotape and various quantitative measurements) for dissemination to all potential bidders during the bidding phase of the project. Sponsoring a pile driving demonstration, at whatever time, will cost money.

Providing a pile driving demonstration during the bidding phase would provide useful information to prospective bidders, resulting in better, more realistic bids and fewer claims, and would provide an indication to designers if the proposed design is feasible. It would afford the COE an opportunity to validate specifications concerning pile driving, particularly if procedural specifications are to be used. Addenda would be required, of course, if specification changes were needed. This may necessitate extending the bid period in order to give the COE an opportunity to distribute and the contractors to consider the addenda. The demonstration could be

made mandatory for all potential bidders, thus reducing or eliminating the need for the COE to record the results.

Again, sponsoring any kind of a demonstration will cost money. Doing it during the bid period may not provide the COE with sufficient reaction time to alter the design or specifications if problems were discovered. Project delay could result.

Failure to conduct a pile driving demonstration would save up-front money, but could result in higher bids if contractors are forced to boost contingencies. It could also result in increased claims if actual conditions differ from assumed conditions. Designers will not know until construction actually begins if there is a problem with the proposed design or pile driving specifications. This could result in delays and/or claims.

It is not unreasonable to expect that money spent up-front on prebid demonstrations of critical elements, like sheet piling, will yield returns many times as great over the long run in terms of fewer changes, fewer claims, and lower dispute resolution costs.

For this reason, the COE should sponsor a pile driving demonstration as early in the detailed design phase as possible. This demonstration should involve construction of a section of sheet pile wall of sufficient length to validate the proposed design and demonstrate the difficulties to be encountered in driving piles, excavating, and placing the required stone.

The demonstration should be widely advertised to attract as many potential revetment construction bidders as possible. The COE should record the results of the demonstration by videotape, still photos, and quantitative measurements for dissemination to all potential revetment bidders.

The same specifications should be used for the test as are proposed for the actual project, and the specifications should be amended as required based on the results of the test.

For ease of administration, the pile driving demonstration should be combined with any dewatering demonstrations under one contract.

In the event a pile driving demonstration cannot be accommodated in the design phase, a demonstration should be performed as a mandatory prebid demonstration for all potential revetment bidders. If this approach is taken, an alternate sheet pile design incorporating tiebacks and any other necessary changes should be prepared ahead of time in the event the prebid demonstration reveals that jetting will be needed. Preparing such an alternate design ahead of time will greatly expedite issuing addenda and reduce or eliminate delays in starting revetment construction.

5.5.2 Dewatering

The standard revetment sections will not require dewatering, as they can readily be constructed under water. In fact, the project feasibility report suggests that the contractor may want to consider flooding the excavation by cutting a trench from the GIWW in order to help stabilize the slopes of the excavation (COE 1992, GIWW Section 216 Study).

The sheet pile wall sections will not require dewatering either, as they can be constructed under water if necessary. Such construction, however, would probably be more expensive. For this reason, the contractor may elect to dewater the sheet pile sections if feasible. Knowledge of the problems to be encountered in

attempting to dewater the sheet pile sections, therefore, is vital in putting together a bid.

Of the revetment's 8-mile length, about 2700 feet, or a little more than six percent, calls for the stone and armor units to be placed upon a compacted clay foundation, owing to the weakness of the insitu soil.

Unlike the standard revetment and sheet pile wall sections, these revetment sections incorporating the rolled clay will require dewatering; the proposed design will not work if the excavation cannot be dewatered. It is assumed that there is some point at which the cost of dewatering the excavation in order to be able to use the rolled clay design will exceed the cost of switching to an alternate design.

COE representatives at the CII Constructability Symposium stated that they thought sump pumps would work, but if not, well pointing would be the only alternative.

The contractor representatives at the CII Constructability Symposium favored a dewatering demonstration during the bid period, calling for tests to be done at several points along the proposed revetment, particularly those areas calling for the rolled clay and sheet pile wall sections.

Conducting a dewatering demonstration during the design phase of the project would enable the COE to determine the feasibility of the proposed design, and afford time to amend the design if dewatering was found to be prohibitively expensive. It would also provide valuable information to potential bidders, resulting in more accurate bids with less potential for claims and related problems.

On the negative side, as with virtually any demonstration done during design, as opposed to the bidding phase, it would require effort on the part of the

COE to publicize the demonstration in order to attract a large number of potential bidders, and would require capturing the results of the demonstration (via videotape, measurements of seepage rates, etc.) for dissemination to potential bidders during bidding. It would also, of course, cost money.

Conducting a dewatering demonstration during the bidding phase of the project could be made mandatory for all bidders, thus eliminating the need for the COE to try to record the results, although they may elect to do so anyway as a claim defense. It would provide valuable information to potential bidders, resulting in more accurate bids with less potential for claims and related problems.

Such a demonstration would still cost money, and may not provide the COE with sufficient reaction time to alter the design if problems are discovered. Project delay could result.

Not conducting a dewatering demonstration of any kind will not cost any up-front money, but greatly increases the likelihood of claims and/or delays if the design of the rolled clay sections is found not to be feasible. It could result in higher bids, if contractors are forced, due to lack of information, to assume the worst, and include large contingencies in their bids. Contractors who gamble and do not include such contingencies, and who encounter worse than anticipated conditions are likely to a) go bankrupt, b) make claims, or c) attempt to "cut corners" to recoup lost money.

The feasibility of dewatering will determine the feasibility of the proposed design. The feasibility of the design must be known before putting the project out to bid; to do otherwise would simply accept a large risk unnecessarily. For this reason, a dewatering test should be performed as early in the detailed design phase

as possible. The tests should be done at several points along the length of the revetment, with particular emphasis on the rolled clay and sheet pile sections. The test should be widely advertised, and the COE should record the results of the test.

The COE should immediately begin considering alternatives to the rolled clay design so they are available in the event dewatering proves infeasible.

The dewatering test should be combined with the pile driving demonstration discussed in the previous section under one contract.

In the event a dewatering test cannot be done during the design stage, one should be done as a mandatory prebid demonstration for all potential bidders.

5.6 Responsibility for Procuring Permits

The project Environmental Impact Statement seems to indicate that no Section 404 permits will be needed for the project, stating (COE 1992, GIWW Section 216 Study):

> Section 404(r) provides an exemption from obtaining either a state water quality certificate or a 404 permit if certain requirements are met...When this report and EIS are submitted to Congress for authorization, the exemption requirements of Section 404(r) will have been met.

COE representatives at the 5 Mar 93 design meeting with CII were not aware of this statement, and were unsure whether Section 404 permits (or any other permits, for that matter) would be needed.

The contractor representatives at the CII Constructability Symposium assumed that Section 404 or similar environmental-related permits would be

needed, and felt it would be better if the COE were to obtain the necessary permits and then clearly state what would be required of contractors in the contract documents.

By having the COE get the permits and then clearly state in the contract documents what will be expected of the winning contractor, potential bidders will be able to put a price on the work and include it in their bids. To have the contractor get the needed permits will mean that the winning contractor will not know exactly what will have to be done until after bid award. This will make it extremely difficult to accurately price the work in putting bids together. Prudent contractors will probably include sizable contingencies in their bids, possibly making the project cost more than necessary. A contractor who does not include a large enough contingency only to find requirements greater than what were assumed may resort to claims or cutting corners to attempt to recoup unforeseen costs. Having the COE obtain the permits could speed up the project if permitting can be done concurrently with other preconstruction activities such as final design or real estate acquisition.

A disadvantage of this approach is that it will require more work by the COE to obtain the permits. Also, the winning contractor may plan to do the work in a manner different from that envisioned by the COE during the permitting process, thus rendering the permits void or, as a minimum, requiring they be amended. This approach could subject the COE to claims if the actual permit requirements differ from those advertised in the contract documents.

Having the contractor get any required permits means less work for the COE, and lessens the likelihood of the COE facing claims arising from permits.

There are significant disadvantages to making the contractor responsible for procuring permits. It would be extremely difficult for contractors to price the work required to comply with various environmental requirements, and could result in delay in actual revetment construction due to the time required for the contractor to get the permits.

Because this is a time-sensitive project, the fact that having the COE secure the needed permits concurrently with other prebid activities will speed up the project is a significant argument in favor of this approach.

Explicitly stating what will be required of the contractor to comply with the permits may or may not result in lower bids than what otherwise would be received, but will almost surely save money overall due to fewer claims.

The disadvantages of having the COE obtain the needed permits can be minimized through good design and management, and involvement of other key agencies in project partnering efforts.

The first order of business is for the COE to determine definitively whether Section 404 permits (and any other permits) are required. If permits are not required, this fact should be explicitly stated in the contract documents.

If such permits are needed, the COE should obtain said permits prior to bidding the project and explicitly state in the contract documents what will be required of the contractor.

The contract documents should explicitly make the contractor responsible for obtaining, at the contractor's expense, any modifications or additions to these permits necessitated by the use of different methods.

5.7 Payment Basis for Mobilization/Demobilization

The standard COE breakdown is 60% paid upon mobilization and 40% paid upon demobilization. The COE has flexibility to amend this ratio if circumstances warrant.

The Sargent Beach project is equipment and materials intensive, and will involve a large effort to move equipment and materials to the site to enable work to begin. For this reason, the contractor representatives at the CII Constructability Symposium called for mob/demob expenses to be paid on a 75%-25% split.

If a contractor's progress payments do not meet costs, then the contractor will probably be forced to borrow money to finance the job. Contractors will probably borrow money on a shorter-term basis and pay higher rates than would the government. The contractor's cost of borrowing money will probably be passed along to the COE in the form of a higher bid.

The COE could stick with the standard 60%-40% split. Doing so would defer payment of a portion of the mob/demob costs. This approach, however, may cause the contractor to have to borrow money if expenses exceed progress payments. This could result in higher bids or contractor financial difficulties.

Providing a higher payment for mobilization may improve the working relationship with the contractor, and be a financial bolster, with less pressure to cut corners or resort to claims. It could result in lower bids.

The disadvantages of a higher payment for mobilization are that it may result in at least a temporary windfall to the contractor if mobilization costs are overstated, and it slightly reduces the leverage the COE has over the contractor at the end of the job. It should be noted, however, that higher mobilization payments

are made only when contractor invoices clearly document actual expenditures for authorized mobilization expenses.

Because of its remote location and the large amount of preparatory work required, the project probably does warrant a greater than normal percentage paid for mobilization. The question then becomes what the split should be. The contractor representatives wanted a 75%-25% split; even if this is slightly overstated, the cost of granting this should be small compared to the potential benefits to be gained.

Mobilization/demobilization costs should, therefore, be paid on a 75%-25% split.

5.8 Progress Payments for Armor Units

Approximately 68,000 armor units will be required for the revetment.

The consensus of the contractor representatives at the CII Constructability Symposium was that precast concrete armor units would be used, and that the casting yard to make them would not be set up on the island, but would be located on the mainland close to the material sources. Finished armor units would then be barged to the site for installation.

The contractor representatives called for the COE to make progress payments on completed armor units at the casting yard, with the rest payable upon installation.

The COE could choose to make payments solely for installed blocks, without progress payments during the block production process. This approach eliminates the need for the COE to verify the contractor's claims concerning the

number of blocks completed at the casting yard. It also provides a strong incentive for the contractor to be expeditious about getting to work so the armor units can be put in place and the contractor can get paid.

The disadvantage is that it forces the contractor to finance production of the blocks. This could put the contractor under a financial strain and/or lead to higher bids for the job. It may put the contractor under increased pressure to hurry up and get the armor units in place in order to get paid for them. This could detract from quality, and would put a greater burden on the COE concerning quality assurance.

Making partial payments at the casting yard and the remainder upon installation reduces the need for the contractor to finance armor unit production. This should help the contractor and the suppliers financially, and may reduce bids. There would also be less pressure on the contractor to hurry up and get the armor units in place. This should be more conducive to higher project quality with less burden on the COE to enforce quality.

Making such payments may impose the requirement on the COE (if it feels the need) to verify the contractor's assertions as to the number of completed blocks.

Maintaining a positive cash flow is frequently a critical problem for construction contractors; it is clearly in the owner's best interest to help the contractor do so. Making progress payments on the armor units as they move through the production process is one means of doing that.

There are several potential points in the production process at which progress payments could be made. As suggested by the contractor representatives, a logical and equitable choice is to pay the contractor 100% of direct production costs for completed blocks at the casting yard, and the remainder upon installation.

A set price per block should be negotiated prior to the start of production. These provisions should be explicitly stated in the contract documents, since they may influence contractor bids.

5.9 Payment Basis for Concrete Sheet Piling

An estimated 2110 sheet piles, with lengths varying from 41-47 feet, will be needed to build the concrete sheet pile wall sections.

The contractor representatives at the CII Constructability Symposium were not able to reach a consensus concerning the payment basis for sheet piling. Some representatives favored paying on a per pile basis, while others preferred to be paid on the basis of linear feet of piling installed.

A reasonable approach would be for the COE to estimate the numbers of piles of various lengths that will be required, and provide this information to the contractors in the contract documents as a basis for unit price bids. The piles should be bid and paid for on a unit price "per pile" basis using this approach. The standard variation of quantities clause should be used for any required adjustments.

5.10 Bid Bases

The following bases should be used for bids and payments:

- Armor Stone	Each
- Blanket Stone	Ton, Barge Measure
- Core Stone	Ton, Barge Measure
- Toe Stone	Ton, Barge Measure
- Geotextile	Square Yard, in place

- Excavation	Cubic Yard (Includes excavation, stockpiling, and backfilling)
- Select Fill	Cubic Yard (Includes placement and compaction)
- Pile Cap	Linear Foot
- Haul Road	Lump Sum
- Landscaping	Linear Foot (Measured along the structure centerline)

5.11 Use of Incentives and/or Liquidated Damages

5.11.1 Incentives

Several contractor representatives at the CII Constructability Symposium said they felt that incentives were appropriate on projects where the owner would benefit from early completion of the job. They also said that such incentives frequently motivated them to complete jobs early in order to get the bonuses; in other words, if properly structured, incentives work.

Including incentive provisions in the revetment construction contract could motivate the contractor to complete the project ahead of schedule, but would then cost the COE additional money if the contractor met the incentive milestones. Incentives could increase pressure on the contractor to cut corners in order to get those incentives. This would increase the quality assurance burden on the COE to ensure project quality.

Assuming that the erosion rate estimated in doing the design remains valid, and project completion as currently scheduled is sufficient to protect the GIWW

from the Gulf, there is no measurable benefit to the COE in having the project done early; this indicates that the use of early completion incentives is probably not justified. There would be some theoretical benefit to the owner, however, if the project were done early, and early completion could mean higher profit for the contractor. There is therefore no reason to prevent a contractor from finishing early, other than any budgetary limitations arising from the appropriation process.

If the beach erosion rate does increase or a large storm or series of storms eats away huge amounts of real estate, this could necessitate early project completion. In this case, the COE could negotiate a change order with the contractor incorporating appropriate acceleration incentives. This approach will require that the COE continue to monitor erosion rates throughout the construction phase.

5.11.2 Liquidated Damages

While there may not be monetary benefits to the COE for early completion, there are potentially significant costs if the project is finished late. Late completion of the revetment could result in the Gulf of Mexico breaching the remaining land separating it from the GIWW, resulting in disruption to GIWW traffic and increased dredging costs.

Use of liquidated damages provisions in the revetment construction contract provides an incentive to the contractor to finish as scheduled in order to avoid paying liquidated damages. Liquidated damages would also at least partially offset any additional costs incurred by the COE in the event the project is not done on time and additional GIWW dredging is required due to a breakthrough. Liquidated

damages are frequently a useful bargaining chip for owners in trying to settle disputes.

The inclusion of liquidated damages provisions may result in higher bid prices if contractors include contingencies to cover potential liquidated damages. However, no contractor representatives at the CII Constructability Symposium objected to the use of liquidated damages on the project.

While it is debatable how great an incentive the threat of liquidated damages represents (contractors say the overhead costs they are forced to assume due to late completion are usually much higher, and hence painful, than liquidated damages), they do represent at least some incentive to finish on time, and are probably worth whatever they cost the owner in terms of higher bids. Liquidated damage provisions should be included in the contract documents.

5.12 Use of Small and Disadvantaged Business Enterprises

The contractor representatives at the CII Constructability Symposium did not foresee use of a large number of subcontractors on the project; most of the work, they said, would be done in-house. The only two likely subcontractors they identified were for landscaping and portable toilets. The contractor representatives raised no objections to the COE establishing DBE goals, as long as they were just goals and not hard and fast requirements.

Additional services which could possibly be contracted include:

- Construction equipment rental
- Construction equipment repair and/or servicing
- Trucking

- Barge rental
- Materials testing
- Insurance
- Construction surveying
- Temporary storage or office facilities.

Material suppliers are likely to include:

- Armor units
- Core/toe/blanket/crushed stone
- Geotextile fabric
- Office supplies
- Fuel/oil/lubricants
- Concrete sheet piles
- Construction equipment repair parts
- Cement/sand/gravel or ready-mix concrete
- Form lumber and rebar.

The armor units, concrete sheet piles, and core, blanket, and toe stone represent the vast majority of materials to be purchased, and the fact that they are needed in such massive quantities means that there may be few, if any, DBEs capable of supplying the needed quantities. The construction contractor will probably not want to split up purchases of these items among several different suppliers because this will likely defeat the economies of scale that would otherwise be achieved. For the COE to mandate that the contractor do so in order to achieve specified DBE goals will almost certainly increase the cost of the project and impose a greater burden on the COE as far as quality assurance goes.

The fact that there are likely to be few, if any, subcontractors used on the project coupled with the large quantities of but a few materials needed will probably make it more difficult than normal for the prime contractor to achieve a high DBE goal. For this reason, the COE's standards for DBE participation should be stated only as a goal, and not a requirement, and should be set realistically considering the nature and location of the project.

There are actions the COE and contractor can take, however, to attempt to meet these goals. The COE should actively strive to generate DBE interest in the project through extensive advertisement and recruitment campaigns. Additionally, this issue should be addressed as part of any partnering effort undertaken between the COE and the contractor on the project.

5.13 Builder's Risk Insurance

The contractor representatives at the CII Constructability Symposium were split on the issue of whether or not builder's risk insurance could be obtained for the project. They agreed, however, that if it was available, it was likely to be very expensive.

Several contractor representatives said that they would probably procure builder's risk insurance only if the COE mandated it, due to its expected high cost. Given the questionable availability and unquestioned high cost, and assuming the COE would be protected under the terms of a performance bond, builder's risk insurance should not be mandated on this project.

5.14 Source of Materials for Rolled Clay Section

The Engineering Appendix to the project Feasibility Report, in discussing the rolled clay sections, states that "Stiff clays will be selected from excavations in adjacent reaches to make the backfill in these reaches" (COE 1992, GIWW Section 216 Study).

This statement sounds like a positive affirmation that suitable clay will be found on site. If that is the assumption that the COE wants contractors to make, then that should be explicitly stated in the contract documents. The COE should also either positively identify the location(s) from which the material is to be obtained, or expressly state that it is up to the contractor to locate the material. The contract language concerning the source of clay is crucial, since there are potentially vast differences in cost between obtaining the material on site and having to barge it in from another location.

5.15 Additional Points That Should be Addressed in the Specifications

1. GIWW rules
   - special permits needed
   - mooring of barges in the GIWW in the vicinity of the project while awaiting offloading, etc.

2. Surface finish requirements, if any, for concrete armor units.

3. Acceptable levels of damage to armor units before rejection.

4. Finish grade control requirements of the revetment.

5. The extent to which backfilled materials must be graded.

6. Procedures for disposing of abandoned septic tanks encountered.

5.16 Length of the Bid Period

The contractor representatives at the CII Constructability Symposium felt that a 30-day bid period was sufficient for putting together bids for this project.

A 30-day bid period should be used, beginning after issuance of plans and specifications, with additional time granted for addenda as required.

5.17 Project Schedule

In order to provide the COE with a basis for comparison with the contractor's plan, a project schedule has been developed. In developing this schedule, the following assumptions were made:

a. A single contract is used for construction of the revetment.

b. Two mooring facilities are built under separate contract and are completed prior to awarding the revetment construction contract. These mooring facilities will remain in place following completion of revetment construction.

c. The COE dictates that the concrete sheet pile wall sections are to be constructed first.

d. The COE supplies Section 404 and any related permits.

e. The location of the haul road is left to the contractor's discretion. Haul roads will be left in place following completion of revetment construction in order to support future revetment maintenance and repair operations.

f. Precast concrete armor units are used. The revetment construction contractor elects to operate the armor unit precast plant rather than contract with an existing supplier.

g. The contractor purchases the concrete sheet piles from a supplier.

h. The contractor will make some additions or alterations to the mooring facilities to enhance material handling efficiency.

i. The contractor will make some additions or alterations to the staging areas adjacent to the mooring facilities. These staging areas will remain in place following completion of revetment construction.

j. The revetment construction contractor elects to operate two work faces.

k. The haul road design calls for a geotextile fabric to be placed on top of a prepared subgrade and covered with select fill barged in from off the island.

l. Sheet pile tie-backs are not required.

m. Any dewatering required is accomplished through the use of sump pumps; wellpoints are not needed.

n. The COE will accept revetment sections with landscaping as a punchlist item. Landscaping will be done as a continuous operation upon completion of major segments so as to maximize its efficiency.

o. A precast concrete pile cap will be emplaced prior to any excavation adjacent to the sheet pile wall sections, either because it is specified by the COE or because the contractor chooses to do so.

p. The contractor's stone supplier(s) is a COE-approved source; therefore 15 days is sufficient time for the COE to review and approve stone submittals.

The project Work Breakdown Structure which served as the basis for the schedule is included as Appendix M. The general scenario upon which the network is based is as follows:

a. Following mobilization, the shorter sheet pile wall section running from station 333+00 to station 340+80 would be constructed first. Work would proceed from east to west, or from station 333+00 toward station 340+80.

b. After the piles for this section are driven, the pile driving crew would relocate to the longer sheet pile wall section and begin placing piles from station 108+00 west to station 78+60.

c. After the excavation and stone and armor unit placement crews working on the east end of the revetment complete the shorter sheet pile wall section, they will continue working in an easterly direction to the end of the structure. As they progressed eastward, they would install, in order, the rolled clay revetment section from station 340+80 to station 368+50, and then install the 1V:5H and 1V:2.5H concrete block revetment sections as appropriate. The last section emplaced would be the end section, which terminates at station 419+92. They will then relocate

and begin building the revetment from station 333+00 in toward the center.

d. After the pile driving crew relocates from the shorter to the longer sheet pile wall section and commences work, additional excavation and stone and armor unit placement crews will be brought in to build the structure from station 108+00 to its west end at station 0+00. After reaching this west end, these crews will relocate and start at station 108+00 and work in toward the center, eventually meeting up with the crews working in toward the center from the other end.

Primavera Project Planner Version 5.0 software was used to produce the following items, which are included as appendices as shown:

Item	Appendix
a. CPM Network Diagram	N
b. Logic Report	O
c. Criticality Report	P

The Logic Report lists all activities in ascending order of Activity ID, while the Criticality Report lists all activities sorted by total float and early start. These reports and the CPM network diagram have been prepared on the basis of a seven-day work week, with no allowances for weekends, weather delays, or holidays. This was done to test the network logic and to calculate the overall project duration. The starting date for the project was assumed to be January 1, 1995.

The CPM network was developed using the precedence technique. The network contains 148 activities, of which 40 are critical. The CPM network has multiple start activities, all triggered by the contractor's receipt of the Notice to

Proceed. The project duration is 525 working days, which, assuming a five day work week, is equivalent to 735 calendar days, or slightly more than two calendar years. Factoring in holidays and weather delays will, of course, increase the scheduled duration. In any event, it is evident that the Sargent Beach project can be built within the allotted three-year construction period.

Durations for revetment construction activities were calculated using estimated production rates for representative types of equipment. The contractor's estimated durations will, of course, depend upon the actual types and numbers of equipment the contractor actually employs on the project. Durations for many of the mobilization and demobilization activities were selected arbitrarily, as there was not sufficient information available to make precise calculations.

Construction of the sheet pile wall and armor unit revetment sections are characterized by a series of sequential, yet echeloned, activities. For the assumed equipment configurations, the pile driving and excavating operations are the pace-setting activities; in other words, they lie along the critical path. Activities that follow these operations can begin as soon as one day after beginning the preceding activity, but also cannot finish until that preceding activity is first completed. These relationships are depicted on the network diagram through the use of start-to-start and finish-to-finish relationships with, in most cases, one day lags. In order to depict these relationships using the project planning software, it was necessary to break up each of the sequential activities into two activities, "Start Activity" and "Finish Activity." The split of the overall duration between "Start Activity" and "Finish Activity" was arbitrary; in this case, activities were "front-loaded," with "Finish Activity" durations equal to one day.

It is estimated that the revetment construction crews working in toward the center will meet at Station 176+00. This estimate is based on the assumed rate of advance and the fact that, under this scenario, the crew working from the east to the west will begin work on this section of the revetment well in advance of the crew working from the west to the east. As a result of this head start, the crew working from the east end is expected to build 15,700 feet of the center portion of the revetment and the crew working from the west end is expected to construct 6800 feet.

It should be noted that not all 90 days of Activity 9400, "Landscape From Sta 108 to Sta 333" lie on the critical path. Examination of the early finish dates reveals that, in fact, only three days of this activity are critical. This is achieved through the use of finish-to-finish relationships with three day lags. The intent of this approach is to say that it is expected that landscaping of this stretch of the revetment would be done as revetment construction progressed, and that only three days would be needed to complete landscaping once revetment construction was complete.

CHAPTER 6
CONCLUSIONS

Conclusions drawn concerning risk assessment and project controls for the Sargent Beach project are assembled here for easy reference. The paragraph numbers in parentheses refer to the sections of previous chapters containing the analyses that led up to these conclusions. Corresponding recommendations are summarized in Chapter 7.

RISK ASSESSMENT (CHAPTER 4)

Weather Emergency (4.2)

1. A hurricane, tropical storm, or other weather event with the potential to cause severe damage to the project will probably strike the Sargent Beach area at least once during construction.

2. In the event of such a storm, it is feasible and desirable for the contractor to evacuate personnel and equipment from the project site to a safe harbor, given sufficient lead time.

3. The allocation of risk pertaining to weather emergencies and the potential they have for damage to materials, temporary facilities, utilities, etc. is likely to have a significant impact on contractor bids.

4. To be most effective, the risk allocation strategy for weather emergencies must give the contractor (and not the COE) the responsibility for determining when a project shutdown is required or justified, yet must also give the contractor a very strong incentive to keep such shutdowns to an absolute minimum. The strategy should also minimize contractor contingencies.

Transportation Failure (4.3)

1. Barge movement on the GIWW will be the primary means of transporting bulk materials and heavy equipment to the project site.

2. Water transport failure could result from factors within the contractor's control, such as equipment breakdown or operator error, or outside the contractor's control, such as closure of the GIWW, a lock, or another waterway due to accident or weather.

3. Land access to the project site is likely to be interrupted by mechanical failure of the Texas DOT's swing bridge at the end of FM 457 at least once during the construction phase of the project.

Placement Failure (4.5)

1. In general, construction contractors prefer performance over procedural specifications provided the contractors have at least a fair degree of confidence in the proposed design.

2. Use of performance specifications for a design in which the contractors lack confidence will cause contractors to include large contingencies, thus yielding higher bids.

PROJECT CONTROLS (CHAPTER 5)

Government Furnished Facilities, Materials, or Equipment (5.1)

1. Constructing the mooring facilities under a separate contract will speed up the overall project.

2. All contractors are likely to have at least slightly different ideas as to how to best organize equipment and material unloading. As a result, the winning contractor is likely to want to make at least minor additions or changes to any mooring facilities provided by the government.

3. Well-designed and constructed mooring facilities will enhance contractor productivity in material handling. Conversely, poorly-designed or constructed facilities will inhibit productivity and likely result in higher bids.

4. Input into mooring facility design by potential revetment construction contractors should result in an improved design.

5. There are a sufficient number of existing precast plants capable of supplying armor units so that armor units would not be "sole-sourced."

6. Armor units do not constitute long lead time items.

7. Staging areas adjacent to the project site on the mainland side of the GIWW will not be required.

8. Staging areas adjacent to the mooring facilities on the island will be required.

9. The proposed 300 foot construction ROW is of sufficient width to permit materials storage within its limits.

Number of Contracts for Revetment Construction (5.2)

1. There is enough interest in the project on the part of large contractors to generate sufficient competition to ensure competitive bids if a single construction contract is used.

2. Small firms who do not have the capability to undertake the entire project by themselves could form joint ventures if the project was to be bid as a single contract.

Partnering (5.3)

1. Partnering improves project performance.

2. Close cooperation with numerous local, state, and federal agencies will be critical to project success. The ability of the COE to bring these organizations into

the "project team" could influence contractor bids and is likely to influence the overall success of the project.

Dispute Resolution (5.4)

1. The inclusion of provisions for Alternative Dispute Resolution in the contract documents should result in lower bids.

2. The claims potential for this project is low to moderate. The most likely source of claims is the sheet pile wall sections.

Bid Demonstrations (5.5)

1. Prebid demonstrations of critical elements benefit the COE as the demonstrations afford the opportunity to validate proposed designs and specifications. Demonstrations benefit contractors by providing more information upon which to base bids.

2. The most critical unanswered questions on the Sargent Beach project pertain to the viability of the proposed sheet pile wall design and the difficulties to be encountered in dewatering the rolled clay section. Failure to provide prebid demonstrations of these items will likely cause contractors to include sizable contingencies, thus raising bids.

3. The proposed design for the rolled clay section is feasible only if this section can be dewatered.

Responsibility for Procuring Permits (5.6)

1. Requiring the construction contractor to obtain Section 404 or similar permits will mean that bidders will not know exactly what will be required of them before submitting bids. This is likely to cause contractors to boost contingencies, thereby raising bids.

2. Having the COE obtain Section 404 or similar permits will speed up the project.

Payment Basis for Mobilization/Demobilization (5.7)

The Sargent Beach project will require a greater than average mobilization effort.

Use of Incentives and/or Liquidated Damages (5.11)

1. Assuming that the erosion rate estimated in doing the design remains valid, and project completion as currently scheduled is sufficient to protect the GIWW, there is no measurable benefit to the COE in having the project done early.

2. There would be no harm or expense to the COE if the project were done early, and early completion would reduce the chances of a storm breaking through to the GIWW. Early completion could result in a higher profit for the contractor due to a reduction in time-dependent overhead costs, for example.

3. There are potentially significant costs to the COE if the project is finished late, particularly in the form of increased dredging costs should the land barrier separating the GIWW from the Gulf of Mexico be breached.

Use of Small and Disadvantaged Business Enterprises (5.12)

1. Relatively few subcontractors are likely to be used on this project; most of the work will be done by the contractor using in-house forces.

2. It will probably be more difficult than normal for the prime contractor to achieve a high DBE goal.

3. A concerted effort by the COE to generate DBE interest in the project and addressing this issue in the course of any project partnering efforts will increase the chances that stated DBE goals will be met.

Builder's Risk Insurance (5.13)

1. Builder's risk insurance may not be available for this project.

2. If it is available, it will be very expensive.

3. Contractors will procure builder's risk insurance only if it is mandated by the COE.

4. The COE's strategy for allocating risk due to weather emergencies will likely be the determining factor as to the availability and cost of builder's risk insurance.

Length of the Bid Period (5.16)

Thirty days is sufficient time for putting together bids for this project. Additional time would be required if addenda were issued during this bid period.

Project Schedule (5.17)

1. The CPM technique is useful in planning and scheduling the Sargent Beach project.

2. The project can be built within a three-year construction period.

3. The precedence technique of CPM diagramming is more suitable than the arrow technique for depicting the echeloned nature of the construction processes likely to be employed on the Sargent Beach project.

4. Pile driving and excavation operations will be the pace-setting or critical activities.

CHAPTER 7

RECOMMENDATIONS

Recommendations concerning risk assessment and project controls for the Sargent Beach project are assembled here for consideration by the COE in organizing the project and preparing the contract documents. As in the preceding chapter, the paragraph numbers in parentheses refer to the sections of previous chapters containing the analyses that led up to these recommendations. It is believed that adoption of these recommendations will result in improved contractor performance and delivery of a project that fulfills its design objectives at the lowest possible cost to the government.

Based on the data collected and analyzed during the course of this study, it is recommended:

RISK ASSESSMENT (CHAPTER 4)

Risk Allocation in General (4.1)

1. That the COE explicitly state in the contract documents who is expected to bear specific risks.

2. That the COE avoid unreasonable risk shifting in the contract documents.

Weather Emergency (4,2)

1. That contractors be required to develop and submit to the COE a hurricane reaction plan detailing the steps the contractor would take in the event of a hurricane or similar storm.

2. That the contractor have the final responsibility for ordering project shutdowns due to impending weather threats.

3. That under whatever weather emergency risk allocation strategy is selected, the construction contractor be made responsible for the cost of repairs to or replacement of contractor-owned or leased equipment and plant.

4. That the contractor be required to insure equipment against storm-related damage.

5. That the standard "Damage to Work" clause be amended to provide for the following:

- The contractor will be entitled to additional payment for repairs to permanent work.
- The contractor will not be entitled to additional payment for repairs to work in process.
- Documented costs (less labor and contractor-owned equipment) for repairs to temporary facilities and utilities, lost or damaged materials, moving equipment off the island or to a safe harbor, and overhead expenses during

a storm-related shutdown will be split 50-50 between the COE and the contractor.

- Coverage will be provided for floods, earthquakes, hurricanes, tornadoes, tsunamis, or tropical storms.

6. That, in order to minimize contractor exposure to the risk of damage to work in process, the "acceptance stations" be made very short, on the order of, say, a couple of hundred feet, rather than 1/4 or 1/2 mile or more.

7. That these provisions be explicitly stated in the contract documents.

Transportation Failure (4.3)

1. That water transport delays due to contractor error be nonexcusable, i.e. the contractor will receive neither time extensions nor additional compensation.

2. That water transport delays outside the contractor's control be excusable but noncompensible, i.e. the contractor will be granted time extensions but will not be entitled to additional compensation to cover disruption-related costs.

3. That the COE not dictate minimum stockpile requirements to the contractor.

4. That the contractor, in order to mitigate the impact of water transport failures, stockpile at least several days' worth of materials on site to enable work to continue despite a disruption in the flow of materials. Surge stockpiles should be expanded

during the winter months as a hedge against weather-induced transportation delays in the spring.

5. That the contract documents explicitly state that the contractor cannot rely on use of the swing bridge.

6. That the COE be expressly exempted in the contract documents from claims arising from failure of the swing bridge.

7. That the contractor be required to develop a contingency plan in the event the swing bridge is disabled. This contingency plan could include identifying and possibly leasing in advance parking and/or marina facilities adjacent to the project site.

8. That these facts and requirements be clearly stated in the contract documents.

Production Failure (4.4)

1. That contractors be required to submit the names of their proposed material suppliers with their bids.

2. That following contract award, the COE verify, using either in-house personnel or an independent materials testing lab, the quality of the proposed stone sources, the nature and quality of the equipment used to produce the stone, and the

production records of the proposed supplier(s) to verify that production capacity is sufficient to support the proposed construction schedule.

3. That the COE review and approve the plans for the proposed precast plant, that COE inspectors visit the plant once it is established or identified to check its set-up, operation, and quality control measures, and continue such checks through periodic unannounced follow-up visits during actual production of the armor units.

Placement Failure (4.5)

1. That, in general, performance specifications be used so as to minimize the COE's risk due to placement failure and afford the contractor maximum flexibility for the use of innovative methods.

2. That performance specifications be used for the sheet pile wall sections if a prebid demonstration (as discussed in Section 5.5.1) is conducted and the proposed design proves satisfactory. Otherwise, procedural specifications should be used.

Administrative Impediment (4.6)

1. That the standard federal clauses pertaining to liability for delays due to administrative impediments be used.

2. That the COE include a "Termination For Convenience" clause in the contract to allow the COE to terminate the contract and cut its losses should the project be delayed or interrupted for an inordinate amount of time.

Labor Strife (4.7)

That labor strife be treated as excusable, noncompensible delay, unless it is caused by one party's bad faith or mismanagement. This should be stated in the contract documents.

Design Error or Omission (4.8)

That the COE bear the risk of providing adequate plans and specifications, and that contractors not be made responsible for design errors or omissions.

Differing Site Conditions (4.9)

1. That the standard federal Differing Site Condition clause be used on the project.

2. That the COE explicitly state in the contract documents that contractors should assume that work will not be done in the surf, but will instead be done behind a section of beach protecting the work zone from the surf.

3. That the COE evaluate the suitability of the proposed revetment design for constructability in the surf.

4. That in the event the design is found to be not suitable for construction in the surf, an alternate design be developed as a contingency plan and put "on the shelf." This alternate design should be model tested at the Waterways Experiment Station.

5. That the COE acknowledge that working in the surf would constitute a Differing Site Condition requiring an equitable adjustment in the contract. Such adjustments could be made via change orders.

6. That the COE consider dictating to the contractor in the contract documents that certain highly vulnerable sections (i.e. those subject to faster erosion or most at risk of storm breakthrough) be constructed first. An appropriate mechanism for achieving this would be to use contractually imposed milestone dates for completion of certain designated sections such as McCabe's Cut and Choctow Lake.

PROJECT CONTROLS (CHAPTER 5)

Government Furnished Facilities, Materials, or Equipment (5.1)

1. That a separate contract be let for construction of mooring facilities such that they are completed prior to awarding the revetment construction contract.

2. That the scope of work of the mooring facility contract include dredging, bulkheads, minimal hardstand, and barge tie-offs.

3. That the revetment construction contractor be permitted to make additions or changes, subject to COE approval and at the contractor's expense, to the mooring facilities to maximize productivity in off-loading operations. This should be explicitly stated in the contract documents.

4. That input into the proposed mooring facility design be sought from both potential revetment construction contractors and potential mooring facility construction contractors.

5. That the contract documents expressly give the revetment construction contractor the responsibility for repairing and maintaining the mooring facilities throughout the life of the contract. The revetment construction contractor should be expected to turn the mooring facilities back over to the COE in the same condition, less normal wear and tear and any approved changes, as when the contractor received them.

6. That at least one of the mooring facilities be designed and constructed so as to support future revetment maintenance and repair requirements. A life cycle cost analysis should be made to determine the optimum design life for this facility.

7. That the revetment construction contractor be responsible for supplying the armor units.

8. That the location of the haul road be left to the contractor's discretion and not dictated in the design. The COE should provide only minimal guidance concerning haul road design criteria.

9. That the revetment construction contractor be responsible for constructing any and all haul roads.

10. That haul roads remain in place following completion of revetment construction.

11. That the only staging areas to be furnished by the COE be those immediately adjacent to the mooring facilities, and that any other staging areas be left to the contractor's discretion.

Number of Contracts for Revetment Construction (5.2)

That a single construction contract be let for construction of the revetment and related work, less the mooring facilities.

Partnering (5.3)

1. That the Galveston District include in the bid documents an offer to enter into a partnering effort with the winning contractor.

2. That, assuming the contractor agrees to partner, periodic follow-up workshops be conducted at regular intervals in order to maintain the spirit of partnering throughout the life of the project.

3. That the key project designers, both in-house district personnel and Kenneth Balk and Associates, be included in the partnering effort, and that this fact be expressly stated in the contract documents.

4. That the COE consider including two or three other key agencies in the partnering effort. This partnering effort should begin in the design phase, so that the partners' concerns can be incorporated into the design and project planning. The partners would continue into the construction phase, providing the contractor agreed.

5. That the COE consider for inclusion in the partnering effort such organizations as:

- Texas Department of Transportation
- U.S. Environmental Protection Agency
- San Bernard National Wildlife Refuge/U.S. Fish and Wildlife Service
- U.S. Coast Guard
- Texas Water Commission
- Matagorda County
- Local Homeowners Associations, if any.

6. That outside facilitators be employed to conduct initial and follow-up partnering sessions.

Dispute Resolution (5.4)

1. That a Dispute Review Board be employed on the project. It should have three members, one appointed by the owner, one by the contractor, and a neutral member agreed upon by the other two members.

2. That should the recommendation to use a Dispute Review Board not be accepted, mediation be used if required.

3. That whatever primary method of Alternative Dispute Resolution is to be employed on the project, it be explicitly stated in the contract documents.

Prebid Demonstrations (5.5)

1. That the COE sponsor a pile driving and dewatering demonstration as early in the detailed design phase as possible. The pile driving demonstration should involve construction of a section of sheet pile wall of sufficient length to validate the proposed design and demonstrate the difficulties to be encountered in driving piles, excavating, and placing the required stone. The dewatering demonstration should include tests at several points along the length of the revetment, with particular emphasis on the rolled clay and sheet pile sections.

2. That these demonstrations be widely advertised to attract as many potential revetment construction bidders as possible.

3. That the COE record the results of the demonstrations by videotape, still photos, and quantitative measurements for dissemination to all potential revetment bidders.

4. That the same specifications be used for the tests as are proposed for the actual project, and that the specifications be amended as required based on the results of the tests.

5. That, in the event these demonstrations cannot be accommodated in the design phase, a demonstration be performed as a mandatory prebid demonstration for all potential revetment bidders.

6. That, if the demonstrations are to be done during the bidding phase, an alternate sheet pile design incorporating tiebacks and any other necessary changes be prepared ahead of time in the event the prebid pile driving demonstration reveals that jetting will be needed. Preparing such an alternate design ahead of time will greatly expedite issuing addenda and reduce or eliminate delays in starting revetment construction.

7. That the COE immediately begin considering alternatives to the rolled clay design so they are available in the event dewatering proves infeasible.

Responsibility for Procuring Permits (5.6)

1. That the COE determine definitively whether Section 404 permits (and any other permits) are required. If permits are not required, this fact should be explicitly stated in the contract documents.

2. That if such permits are needed, the COE should obtain said permits prior to bidding the project, and explicitly state in the contract documents what will be required of the contractor.

3. That the contract documents explicitly make the contractor responsible for obtaining, at the contractor's expense, any modifications or additions to these permits necessitated by the use of different methods.

Payment Basis for Mobilization/Demobilization (5.7)

That mobilization/demobilization costs be paid on a 75%-25% split.

Progress Payments for Armor Units (5.8)

1. That the COE make progress payments on completed armor units at the casting yard equal to 100% of the contractor's direct production costs to that point, with the balance payable upon installation of the unit.

2. That a set price per block be negotiated prior to the start of production.

3. That these provisions be explicitly stated in the contract documents.

Payment Basis for Concrete Sheet Piling (5.9)

1. That the COE estimate the numbers of piles of various lengths that will be required, and that this information be provided to contractors in the contract documents as a basis for unit price bids.

2. That piles be bid and paid for on a unit price "per pile" basis using this approach.

3. That the standard variation of quantities clause be used for any required adjustments.

Bid Bases (5.10)

That the following bases be used for bids and payments:

- Armor Stone	Each
- Blanket Stone	Ton, Barge Measure
- Core Stone	Ton, Barge Measure
- Toe Stone	Ton, Barge Measure
- Geotextile	Square Yard, in place
- Excavation	Cubic Yard (Includes excavation, stockpiling, and backfilling)
- Select Fill	Cubic Yard (Includes placement and compaction)
- Pile Cap	Linear Foot
- Haul Road	Lump Sum
- Landscaping	Linear Foot (Measured along the structure centerline)

Use of Incentives and/or Liquidated Damages (5.11)

1. That incentive clauses not be used on the project. If the erosion rate increases and a breakthrough threatens, then the COE could negotiate a change order with the contractor incorporating appropriate acceleration incentives. This approach will

require that the COE continue to monitor erosion rates throughout the construction phase.

2. That liquidated damages be used.

Use of Small and Disadvantaged Business Enterprises (5.12)

1. That the COE's standards for DBE participation be stated only as goals, and not requirements.

2. That the COE actively strive to generate DBE interest in the project through extensive advertisement and recruitment campaigns.

3. That this issue be addressed as part of any partnering effort undertaken between the COE and the contractor on the project.

Builder's Risk Insurance (5.13)

That builder's risk insurance not be mandated on this project.

Source of Materials for Rolled Clay Section (5.14)

That the COE either positively identify a source for the clay backfill to be used in the rolled clay sections, or explicitly state that it is the contractor's responsibility to locate the material.

Additional Points That Should Be Addressed In The Specifications (5.15)

That the following items be expressly addressed in the contract documents:

a. GIWW rules
   - special permits needed
   - mooring of barges in the GIWW in the vicinity of the project while awaiting offloading, etc.

b. Surface finish requirements, if any, for concrete armor units.

c. Acceptable levels of damage to armor units before rejection.

d. Finish grade control requirements of the revetment.

e. The extent to which backfilled materials must be graded.

f. Procedures for disposing of abandoned septic tanks encountered.

Length of the Bid Period (5.16)

That a 30-day bid period be used, beginning after issuance of plans and specifications, with additional time granted for addenda as required.

Project Schedule (5.17)

That the standard COE scheduling clauses be used in the contract documents.

CHAPTER 8

COE CONSTRUCTABILITY OPTIONS

8.1 Existing System for Design Reviews

Figure 8.1 models the present system or procedure by which COE projects are reviewed.

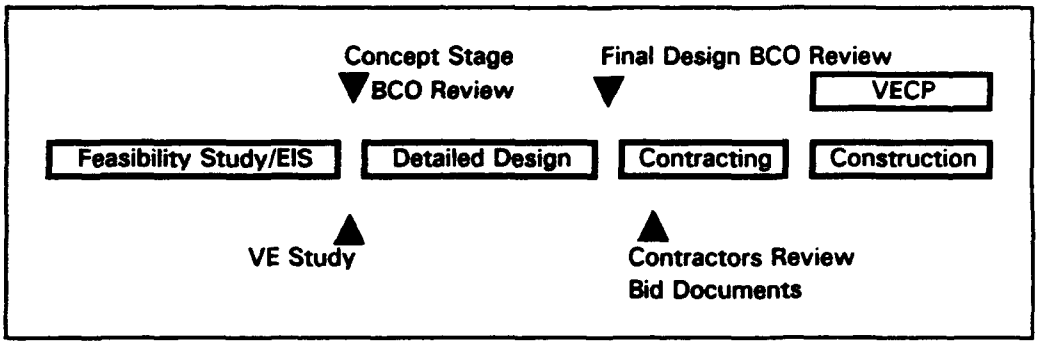


Figure 8.1 Existing COE Review System

The Value Engineering (VE) study is usually performed following completion of the feasibility study but before the start of detailed design. The VE study may be done by an in-house COE VE team or by a private consultant, in most cases an architectural/engineering (A/E) firm. VE teams are typically comprised of architects and engineers experienced in VE studies, but not necessarily experts in the type of facility being studied. The VE teams do not include construction contractor representatives, although the team may contact private industry sources, including construction contractors, to gather information or to test the feasibility of an idea. Such contact is usually made by telephone (Office 1992).

VE studies are mandatory for water resources projects valued in excess of $10 million, and are performed on a percentage of projects valued between $2 million and $10 million based on numerical goals for VE savings. VE studies may also be done for projects valued at less than $2 million if judged cost effective (*Tomlinson 1993. "Conversation"*).

The purpose of a VE study is to review the solution recommended as a result of the feasibility study to ensure that it is, in fact, the most cost-effective solution, and to see if it can, in any way, be made even more cost effective through the use of alternative designs (Office 1992).

A second type of project review is the Bidability, Constructability, and Operability, or BCO, review, which is done in-house by district construction and operations personnel. BCO reviews are performed at least twice during a project's development. The first BCO review is made during the project's conceptual stage, as soon as the design is sufficiently developed to permit substantive comment. The objective of this first BCO review is to provide for incorporation of construction, operation, and maintenance considerations into detailed design development. The second BCO review is performed after all contract documents are complete, but at least 30 days prior to bid advertisement to permit time for corrections, and is intended as a final review of the plans, specifications, and related contract documents before they are distributed to potential bidders on the project (COE 1991).

Under this system, the first opportunity that construction contractors have to see the plans and specifications is when the project is put out to bid. In the course of developing their bids, contractors must review the plans and specifications and,

in accordance with prevailing industry standards, are expected to bring to the owner or A/E's attention any gross errors they find with the design. Contractors generally have neither the time nor the incentive to develop detailed recommendations to improve the project during the contracting phase.

It is only after the contract is awarded that there is any realistic opportunity or incentive for the contractor to apply his or her knowledge and experience to attempt to improve the project. The Value Engineering Change Program (VECP) is a mechanism whereby contractors can recommend changes in the design to attempt to improve the value or cost effectiveness of the design. If the recommendation is accepted and yields cost savings, these savings are split between the contractor and the COE (Tomlinson 1993. "Conversation"). In reality, the effectiveness of this program is questionable, however, since recommendations must go through extensive reviews and may require design revisions, all of which takes time. The contractor, usually faced with a tight schedule and the prospect of having to pay liquidated damages if completion is delayed, can usually not afford to expend a great deal of time proposing changes, particularly if there is a chance the change will not be approved and the contractor is forced to make up whatever time may have been lost pending a VE decision.

While there are several design reviews built into this existing system, there is a perceived weakness in that there is no real opportunity for contractor input until after the construction contract is awarded, and even then, the effectiveness of the VECP program is questionable. Assuming that one accepts the premise that getting construction contractor input into the design process is, in general, a good thing, then there appears to be room for improvement in the existing system.

8.2 Option 1: Constructability Symposium

One option for getting contractor input early in the design process is to sponsor a constructability symposium, much like the technique used in developing the Sargent Beach Constructability Study. A model of this technique is shown in Figure 8.2.

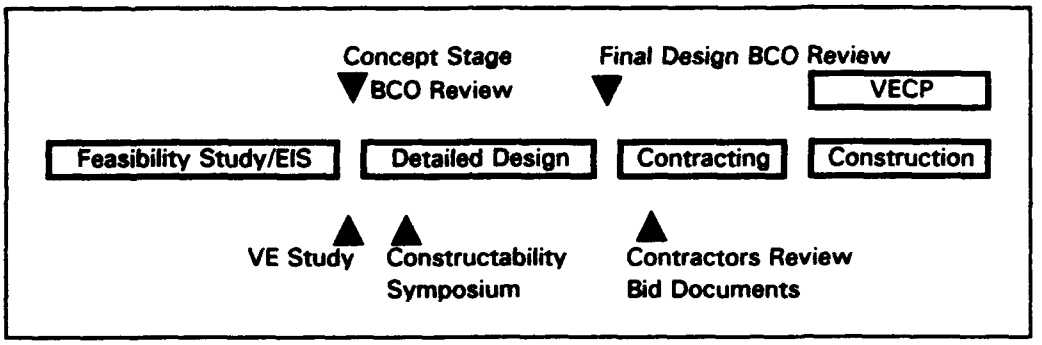


Figure 8.2 Use of a Constructability Symposium

Such a constructability symposium would supplement, not supplant, the COE's existing reviews, and could be conducted by a consultant expressly hired for the purpose or by the COE itself. If the design is being performed by an architectural/engineering (A/E) firm, conducting such a symposium could be included in their scope of work. The symposium should be held as early in the detailed design phase as possible, once the general concept has been decided upon. The symposium would present the design concept and general project overview to contractor representatives for their comment. Feedback gathered from the contractors would then help designers in performing the detailed design. Conducting the symposium early in the detailed design phase is critical, as it

enables changes to be made and action taken before the designers are too heavily committed to a particular solution or design. The factors that go into making a successful constructability symposium are examined in greater detail in Section 8.8 of this thesis.

8.3 Option 2: Contractor-Performed VE Study

A second option for gaining contractor input to the design process would be to hire an experienced construction contractor on a fee basis to perform the VE study in lieu of, in addition to, or as a part of an in-house or A/E VE study. This option is depicted in Figure 8.3.

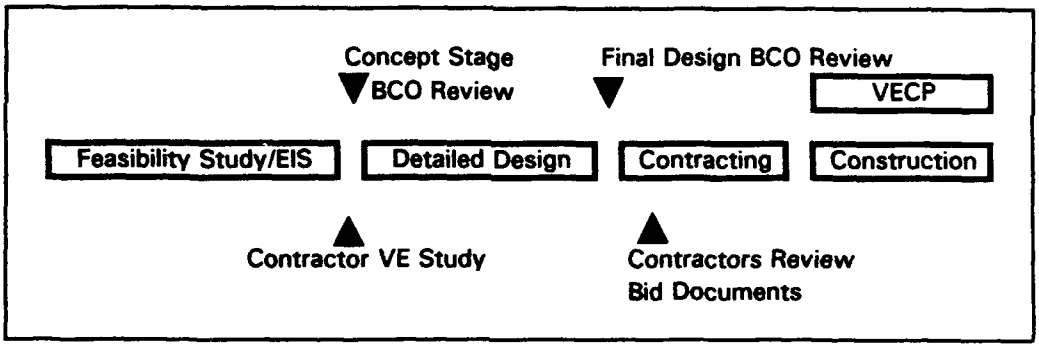


Figure 8.3 Contractor VE Study

If the contractor were to perform the VE study in lieu of an in-house or A/E VE team, then the review would probably have to be limited to a constructability review of whatever option was recommended by the feasibility report. It would probably be beyond most contractors' capabilities to review the economic and engineering analyses that led up to selection of a particular option.

If the COE feels that it is still necessary or desirable to have the VE study validate the recommended solution, then a construction contractor could be engaged to conduct a separate review pertaining solely to the constructability of the proposed solution, or the contractor could participate as part of the VE team.

While any of these approaches will provide the desired contractor input early in the design phase, a serious drawback is the fact that use of a contractor to do the VE study will probably disqualify that contractor from competing for the construction contract due to the potential conflict of interest. It is therefore questionable if highly-qualified contractors could be recruited for such studies. Any consulting fee they would receive is likely to be considerably less than the potential profit from the construction work.

8.4 Option 3: Contractor as Design Consultant

A third option for gaining contractor input would be to hire an experienced construction contractor on a fee basis to act as a design consultant throughout the detailed design phase. Such an approach is graphically depicted in Figure 8.4.

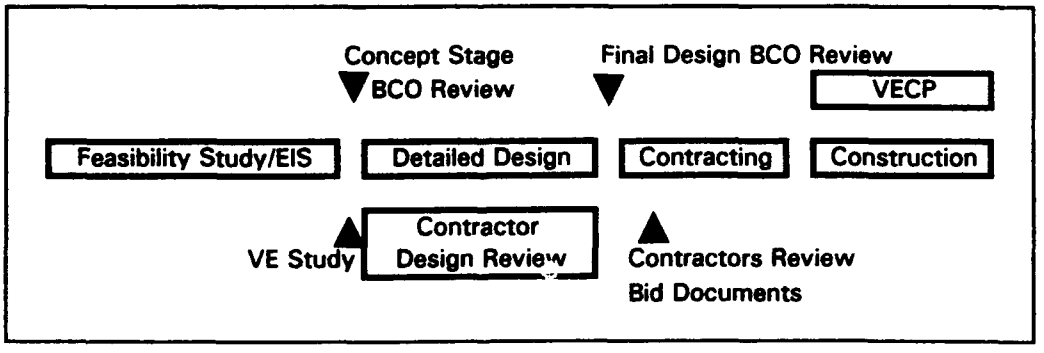


Figure 8.4 Contractor Design Consultant

This option would afford continuous review throughout the design process. This option would probably cost more than having a contractor perform a concentrated VE study, and would in the same way probably require that the contractor be disqualified from competing for the construction work because of the conflict of interest.

8.5 Option 4: Design Review By Prequalified Contractors

Another option is to prequalify construction contractors and then require that they participate in periodic design, or constructability, reviews throughout the detailed design phase as a condition for being permitted to bid on the project. This option is depicted in Figure 8.5.

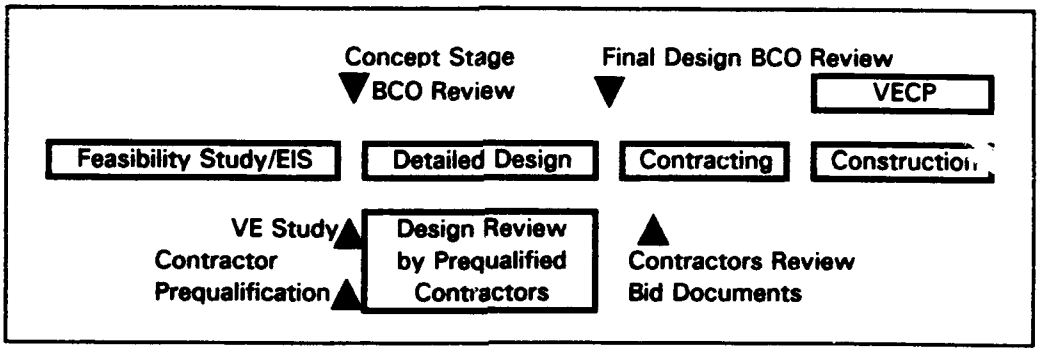


Figure 8.5 Design Review by Prequalified Contractors

By definition, prequalifying contractors limits competition on the project to those contractors who are "prequalified." Given the fact that one of the basic tenets of public-sector work is that it should be awarded, to the maximum extent possible,

on the basis of free and open competition, this option should probably only be used on very complex projects where prequalification of contractors is fully justified.

In order to make the process manageable, the number of prequalified contractors should be limited to, say, three or four, as a general rule. This should be enough to provide competitive bids, yet is small enough that firms are likely to feel that their chances of winning the bid are good enough to justify the time and effort required to participate in the design reviews. This is also not so large a number that it becomes unwieldy for the owner to oversee and manage.

8.6 NAVFAC Experience With the "Prequalification" Approach

8.6.1 Project Description

The prequalification approach was used by the Naval Facilities Engineering Command (NAVFAC) on the Propulsion Training Facility, a $16 million project being built at Naval Weapons Station, Charleston, SC (Collins and Sellers 1991).

NAVFAC advertised the project in the Commerce Business Daily. Nine construction contractors responded. NAVFAC then conducted telephone interviews with these firms to obtain additional information upon which to base their selection. Selection criteria included such factors as experience in the type of work to be performed, past performance, bonding capacity, and ability to participate in the design process. From the original nine contractors, four were selected. NAVFAC then prepared a Determinations and Findings in accordance with DFAR 236.273, thereby establishing a "Qualified Bidders List." The value engineering clause was eliminated from the contract so as to give the contractors no reason to hold back potential cost-saving ideas.

NAVFAC held a kick-off meeting for the four contractors, the customer, and A/E for the purpose of introducing the team members to each other and more fully briefing them on the concept.

The constructability team (A/E, customer, contractors, and NAVFAC representatives) next met after completing a 35% design review. While the consensus was that plans and specifications were not developed enough to permit detailed constructability comments, numerous "large scale" recommendations were made.

A second review was made when design was 100% complete; comments were submitted in writing; no meeting was held. None of the comments called for major structural changes, but were instead centered on seeking clarification of perceived conflicts or ambiguities in the plans and specifications. The A/E responded to each comment, and then NAVFAC returned a complete set of comments, from all four firms, to each contractor.

Following completion of detailed design, the project was put out to bid. The bids came in below the A/E's estimate; the difference between the first and second low bidders was only $27,000 on a $16 million job. Despite their not winning the contract, all three unsuccessful contractors expressed satisfaction with the process and said they would participate in such an arrangement again (Collins and Sellers 1991).

As of this writing, the project is presently under construction. NAVFAC is tracking the project performance, particularly the number of change orders, in an attempt to quantify the impact of the constructability effort.

8.6.2 Expected Benefits of the "Prequalification" Approach

This approach should result in a better set of plans and specifications, not only as a result of the contractors' suggestions and comments themselves, but also due to the fact that the A/E may be spurred to do a better job. It is not unreasonable to expect that the A/E will strive to reduce errors or conflicts between the plans and specifications if it is known that the contractors will be reviewing and critiquing those documents.

There are other benefits that are expected as well. The fact that the contractors are intimately familiar with the proposed design should result in better bids, with less chance that items will be missed or misinterpreted. This should reduce the chances of contractor default or similar financial difficulties, and should also reduce pressure on the contractor to cut corners to recoup money that may have been lost due to faulty estimating. This familiarity may also allow projects to be sped up by permitting bid periods to be compressed, since contractors should require less time to put bids together. The number of requests for information submitted by the bidders should be greatly reduced. (This was the case on the Propulsion Training Facility project. (Collins and Sellers 1991)). This reduces the number of addenda required, with correspondingly less need to extend the bid period. Contractors may reduce contingencies owing to their familiarity with the design, thereby lowering bids.

Perhaps the greatest benefit to all parties may come from a reduction in the number of change orders during construction. This reduction should occur because most problems and conflicts should have been identified and resolved during design. Such a reduction benefits both the owner and the contractor, since change

orders are frequently a source of dispute between the two and are also frequently detrimental to construction productivity.

8.7 Presentation and Analysis of Contractor Questionnaire Results

8.7.1 General

As previously described in Section 3.7, questionnaires were sent to all contractor representatives who had attended the constructability symposium. Twelve of the 14 contractor representatives returned the surveys, making for an 86% return rate. A summary of the responses is included as Appendix Q. It should be noted that some of the question responses total more than 12 due to multiple entries.

8.7.2 Contractor Motives for Attending

Figure 8.6 graphically depicts the contractor representatives' primary reasons for attending the Sargent Beach constructability symposium. Most contractor representatives attended the symposium primarily in order to learn more about the project from a business development standpoint. They sought information that would allow their firms to decide if they should pursue the project any further. Seven of twelve survey respondents said this was their primary motive for attending. This fact indicates that such forums benefit both the owner and the contractors, and can be used as a selling point by the COE when attempting to recruit firms for future symposiums.

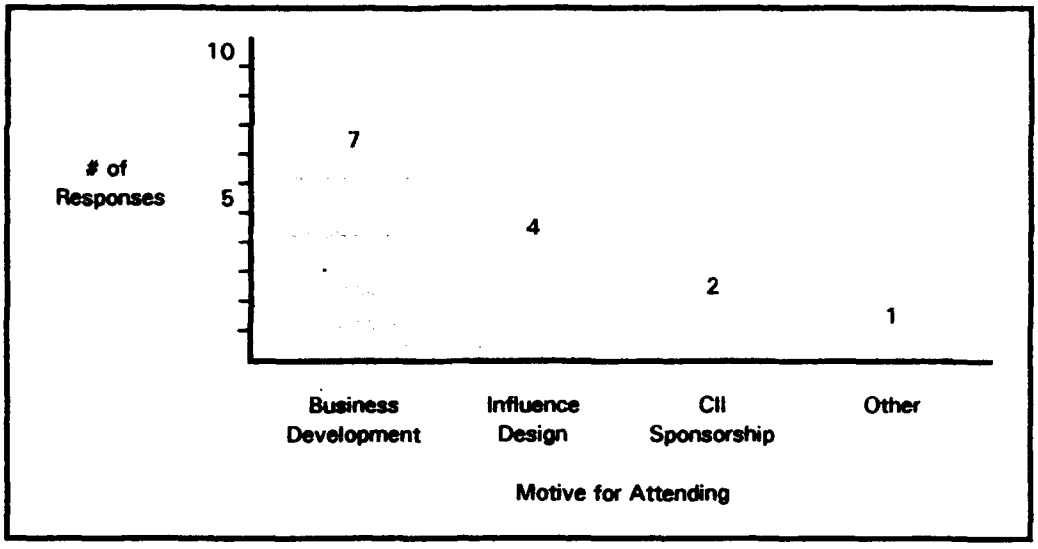


Figure 8.6 Contractor Representatives' Motives for Attending Symposium

The second most common motive for attending was to provide input into the design of the project as a result of the contractor representative's experience in this type of construction. Four of twelve respondents said this was their primary motive for attending. At first glance, this may appear to be a completely altruistic motive, but upon further consideration it is obvious that this, too, is in the contractor's interests. Well-designed projects stand to benefit both the owner and the contractor.

The fact that only two survey respondents said they were motivated to attend primarily by the fact that CII sponsored the symposium indicates that other organizations besides CII should be able to attract contractor representatives to similar sessions.

8.7.3 Contractor Costs to Attend

The contractor representatives attended the symposium from throughout the southeast and midwest. Expenses to attend included airfare, hotel bills, and the cost of their time, and ranged from $250 to $2000. The average cost to attend was approximately $1238. Given the fact that several companies sent more than one representative, and in a few cases, as many as three, the cost to each of these firms could easily reach several thousand dollars.

8.7.4 Contractor Expectations and Perceived Benefits

The answers the contractors gave to the questions about what they expected to get from the symposium and what they actually got from it track closely with their answers to the question concerning their primary motive for attending, as expected. Most expected to get a lead on potential work and to try to help improve the constructability of the design as a result of their experience in the field. Several said they did not know what to expect since this was the first meeting of this kind that they had attended.

The contractor representatives' comments indicate that they generally got what they expected from the meeting, as they learned more about the project and had an opportunity to comment on the design. Several contractor representatives also felt that the symposium was a useful forum for presenting their complaints to the COE in an effort to improve the COE's contracting procedures. Additional benefits cited included interaction with CII and the opportunity to network with other contractors.

8.7.5 Contractor Perceptions of Symposium Success Factors

Question 5 sought to identify what the contractor representatives thought were the most important elements of a successful constructability symposium. The results are shown in Table 8.1.

Analysis of the questionnaire responses reveals a wide range of opinions as to what factors are most important to making a constructability symposium a

# of Responses	Knowledgeable Facilitator	Neutral Meeting Site	Decision-Making COE Reps	Read-Ahead Package	Meeting Facilities	Qualified Contractors in Attendance	Project Overview Briefing	Neutral Agency Sponsor	Well-Prepared Meeting Agenda	Large Number of Contractors Present	Owner Takes Action Based on Results	Ranking	
	2		1	1			1	1			6	1	Most Important
	4		1	1		2		2	1			2	
	2		2	3		2			2		1	3	
			3	1		3	1	2	2			4	
	1		2	2		1	1		2	2	1	5	
	3			1		1	4		1		2	6	
			1	3	1	2	1	1	2		1	7	Least Important
	12	0	10	12	1	11	8	6	10	2	11	Total # of Top 7 Rankings	
	39	NA	38	53	7	47	41	20	46	10	33	Total Points(Note 1)	
	3.3	NA	3.8	4.4	7	4.3	5.1	3.3	4.6	5	3	Average(Note 2)	
	2	11	4	6	10	5	9	3	7	8	1	Ranking by Average	
	1	11	5	2	10	4	7	8	6	9	3	Ranking by Total # of Top 7 Rankings	

FACTORS

NOTES:
1. Total Points = The sum of (# responses)(ranking)
2. Average = Total Points /# responses

Table 8.1 Contractor Representatives' Rankings of Symposium Success Factors

success. The differences separating the ranking of most of the factors are small, and the rankings vary according to the technique used. For this reason, it is perhaps more useful to use the responses to classify factors into categories such as very important, important, and not very important, rather than to produce a rigid numerical ranking.

Using this system, the factors can be subjectively categorized as follows:

Very Important:	- Owner takes action based on the issues
	- Knowledgeable facilitator
	- Quality read-ahead packet
	- Selection of qualified contractors to attend
	- Owner or A/E reps with decision-making authority
	- Well-prepared meeting agenda
Important:	- Project overview briefing
	- Neutral agency sponsor
Not Very Important:	- Large number of contractors represented
	- Meeting facilities
	- Neutral meeting site

The contractor representatives felt that a very important factor is that the owner takes action based on the issues raised in the symposium. Given the time and money required for the contractor representatives to attend, it is no surprise that

they will quickly lose interest in such symposiums if they perceive that the COE is not acting on the recommendations. On the other hand, if such symposiums result in recommendations that lead to improved projects, then contractor interest would probably be heightened. If the COE chooses not to accept consensus recommendations by the contractors, then it is recommended that they explain their rationale. Failure to accept recommendations without reasonable explanations will likely soon kill contractor interest in participating in future symposiums.

Another critical factor cited by those who attended the Sargent Beach symposium was having a knowledgeable facilitator. Contractor comments reveal that it is more important that the facilitator have a good overall understanding of the general construction process than an in-depth knowledge of the particular type of construction being discussed. Some knowledge of design is desirable but not required. This has implications for future attempts to replicate the symposium in that it suggests that the facilitator should have a construction as opposed to detailed design background. This may argue against having an A/E firm run the symposium, although the A/E firm could always hire an outside construction expert to act as the facilitator.

The contractor representatives also considered the read-ahead package to be very important. The vast majority of the contractor representatives at the Sargent Beach constructability symposium demonstrated excellent knowledge of the project that could have been obtained only by studying the packet they had been sent. This suggests that the contractor representatives took the symposium seriously and will read the material they are sent. In the same vein, and in an apparent desire for an

efficient and effective meeting, the contractor representatives also rated the meeting agenda as being very important to symposium success.

The contractor representatives placed a high degree of importance on the selection of qualified contractors to attend the session. This, coupled with the fact that they did not consider having a large number of contractors in attendance to be very important, suggests they favor quality over quantity. This has implications for the COE if it was to try to conduct a constructability symposium itself by attracting contractors through public advertisements. Such an approach may result in the attendance of unqualified contractors whose presence may detract from the quality of the discussion.

The contractor representatives also considered the presence of owner or A/E representatives with decision-making authority to be very important. Comments made at the Sargent Beach constructability symposium indicate that this is due to the contractor representatives' desire to "make their case" concerning some complaints with COE contracting procedures directly to those they perceive to have the authority to do something about it.

The contractor representatives considered the project overview briefing given at the start of the symposium to be of lesser importance. They rated the fact that a neutral agency (i.e. CII) was sponsoring the session of lesser importance as well. This, coupled with the fact that use of a neutral meeting site was, by any measure, the least important factor, indicates that the COE could possibly conduct a constructability symposium itself.

A proper meeting facility with adequate support services was not rated very highly, but it is probable that quality arrangements are expected, and anything less

will probably serve as a demotivator or detractor. Despite the low ranking given this factor by the contractor representatives, it should not be neglected.

8.7.6 Willingness to Attend Future Symposiums

Perhaps the most interesting response was to Question 6, in which all twelve respondents said they would attend a similar symposium for a different project. Narrative comments were similarly positive, and reflect the feeling of the contractor representatives that the symposium was worthwhile.

8.8 Successful Constructability Symposiums

8.8.1 General

This research study in general, and the results of the constructability symposium questionnaire (previously discussed in Section 8.7), in particular, have shown that there are many factors which contribute to a successful constructability symposium. While some are clearly more critical than others, attention to all is needed if the benefits to be gained from such forums are to be maximized.

Figure 8.7 is a cause and effect diagram that graphically depicts the elements of a successful symposium. Note that the process has been subdivided into three phases:

1. Preconference Phase
2. Conference Phase
3. Post-Conference Phase

The elements that make up each phase will now be examined in more detail. The discussion assumes that the owner has already identified the organization which

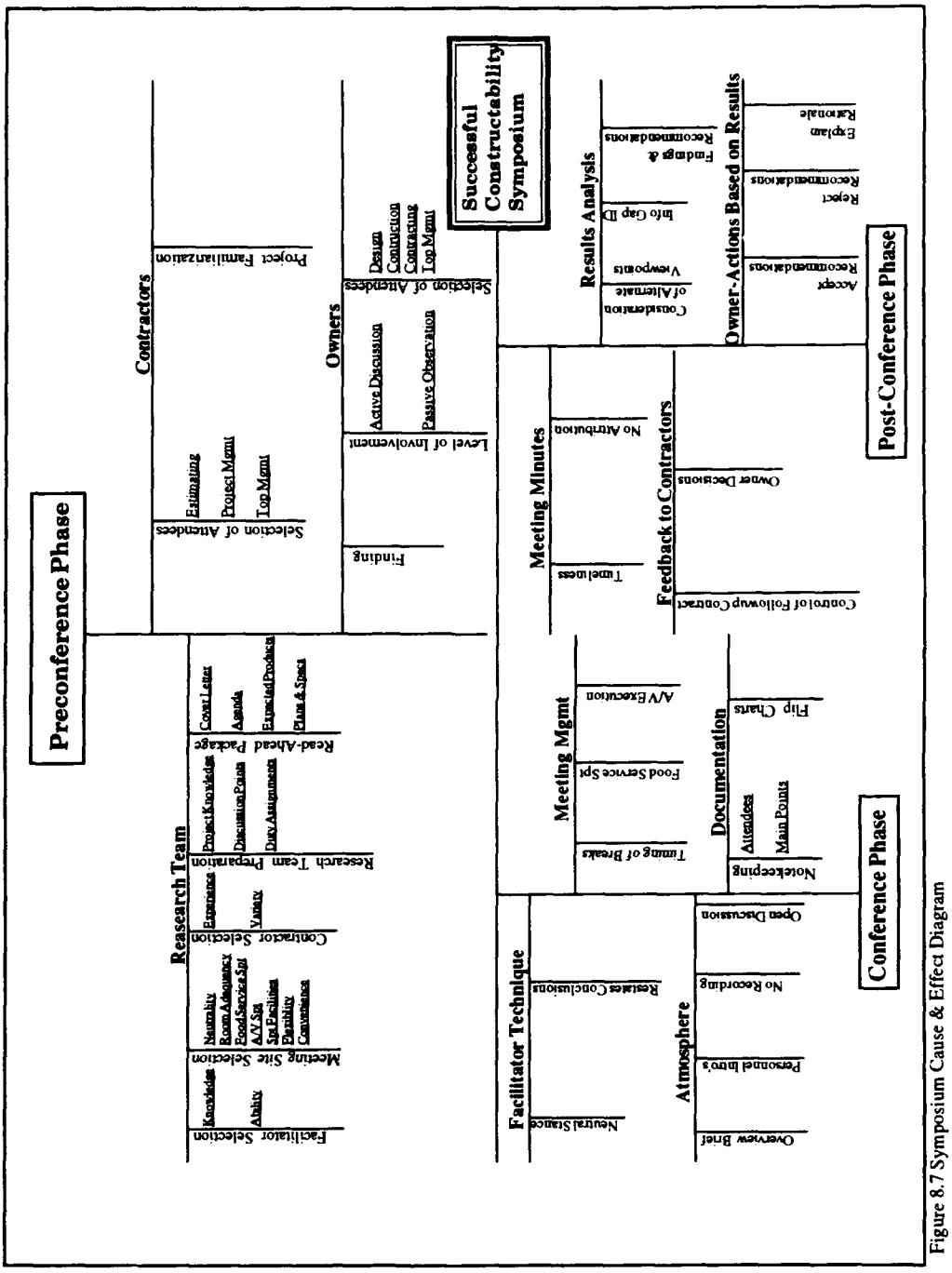


Figure 8.7 Symposium Cause & Effect Diagram

will be conducting the symposium, and that the scope of the constructability study has been defined, to include such things as:

- schedule
- budget
- key points to be examined
- products/deliverables

8.8.2 Preconference Phase

Meeting Site Selection

If the project is large enough, then large national and international contractors may be attending, with their representatives traveling from out-of-town to get to the meeting. For this reason, the meeting site should be as convenient as possible for these contractors. Use of airport hotel meeting facilities is ideal in this regard, as out-of-town contractor representatives can easily fly in and out for the meeting. The start and end times of the meeting should be coordinated with flight schedules to the maximum extent possible. Such airport hotels are usually also readily accessible by highway, thus making them relatively convenient to local contractors as well.

A key consideration in selecting a meeting location, of course, is that it must have facilities adequate to support the meeting. It should have conference or meeting rooms of sufficient size to accommodate the expected number of attendees, and must have the furnishings such as tables and chairs that will be needed. While every attempt should be made to ascertain in advance the number of people who will be attending, the symposium sponsors and the meeting facility must be flexible

to handle increases in numbers caused by unexpected arrivals. Support facilities required include restrooms and telephones.

Attendees should be seated at tables, instead of merely given seats, to facilitate note-taking. The tables should be arranged in a U-shape to better encourage open discussion and to allow all present to easily see any graphic aids used in the presentations. Study team members should sit together to enable them to confer during the course of the symposium.

Food service support will probably be a function of the nature of the symposium and the sponsoring agency. Ideally, some kind of continental breakfast should be available to start things off. Beverages and other refreshments should be available at breaks. A lunch served at the meeting room will save time and also facilitates continued informal discussions among the symposium participants.

Ideally, the meeting facility will also provide such audiovisual equipment as an overhead projector, 35mm slide projector, screen, and flip chart with markers as this will save the study team from having to transport and set up such items.

Research Team Preparation

During the preconference phase, the study team must become intimately familiar with the details of the project. As a minimum, this should include studying all available plans, specifications, feasibility reports, Environmental Impact Statements, and any other documents prepared about the project. Ideally, the team will make a site visit to learn first-hand about any unique site requirements.

Based on what it is that the owner wants the research team to examine, the team must put together a list of discussion points that the facilitator will use to

guide the discussion. Development of such discussion points enables the team to ensure that all key topics are covered.

Prior to the symposium, the team must assign responsibilities. One member should be the meeting facility liaison, responsible for coordinating with the facility manager or other point of contact to ensure that all arrangements are in place and are satisfactory. The liaison should arrive at the meeting site early to check all arrangements and make face-to-face contact with the person responsible for overseeing support to the meeting.

One member should be designated as the flip chart recorder, whose job it is to record any comments or compile lists for all to see during the course of the discussion but particularly during any brainstorming sessions.

In order to encourage as much free and open discussion as possible, it is recommended that the symposium not be electronically recorded; instead, manual notes should be made to facilitate the preparation of meeting minutes. At the Sargent Beach symposium, the pace of discussion was so great that it was necessary to have two people taking notes. The two recorders then compared notes in compiling the meeting minutes to ensure that no pertinent comments were missed.

Facilitator Selection

Selection of the facilitator is a vital element in ensuring success. The facilitator should be knowledgeable of the construction process in general, as this knowledge is needed in order to gain and maintain credibility with the contractors. While a knowledge of the particular type of construction to be discussed is useful, it is not a requirement. The facilitator must possess excellent people and

communications skills so as to be able to encourage free and open discussion, keep the discussion moving, and defuse any conflicts that may arise.

The facilitator must be a neutral figure, soliciting comments from the contractor representatives but not pushing one solution or concept over another. For this reason, the facilitator should not be involved, in any way, with the design of the project.

Contractor Selection

The method of contractor selection will probably be determined by who is conducting the constructability study. If a private consultant is conducting the study, then the consultant could probably legally conduct a limited "by invitation only" symposium. If the COE, on the other hand, were conducting the study, it probably could not legally do so. The COE would probably be forced to advertise the symposium and open it up to any and all interested contractors.

Regardless of whether the contractors are invited to attend or respond to an advertisement, the objective is to assemble contractors who are experienced in the type of construction to be discussed. Another objective should be to attract a representative cross-section of the industry in terms of special skills and abilities as well as geographic location.

The owner or agency sponsoring the symposium must be alert to attempts by contractors to influence the design in ways that would limit competition or otherwise give a certain contractor a competitive advantage. While none of this was evident at the Sargent Beach symposium, the possibility certainly exists. One means of lessening the chances of this happening is to have a representative cross-section

of the industry present at the symposium. Ideally, contractors proficient in various techniques or specialties would be present to present all sides to a problem, rather than hearing from just one point of view. This variety was achieved at the Sargent Beach symposium by inviting both contractors who specialized in dredging and those who did not, in this way hearing "both sides of the story."

If the COE is conducting the symposium and attracting contractors through advertisements, then they will probably not be able to control or limit the number of attendees. This could be a problem in that too many attendees could be unmanageable and detract from the quality of the discussion. Ideally, the number of contractor representatives should not exceed 15 - 20, which, when considering the fact that firms may desire to send two or three representatives each, means that the number of firms should probably be limited to 7 - 10, if possible.

Read-Ahead Package

To maximize the productivity of the symposium requires that the contractor personnel arrive at the meeting with at least a rudimentary knowledge of the project. This will reduce the amount of meeting time that must be devoted to explaining the project and therefore maximize the time available to discuss it. This requires that a quality read-ahead package be sent to all contractor representatives who will be attending.

As a minimum, the read-ahead package should contain:

a. Cover letter

b. Meeting agenda

c. Expected meeting products

d. Plans and specifications, if available.

The read-ahead package should be sent out 2 - 3 weeks before the symposium to afford sufficient time for the attendees to review it.

Contractor Actions

Once a contractor decides to participate in a constructability symposium, the contractor must determine who will attend as representatives. Prime candidates include estimators, project managers, and project superintendents. Personnel who will be attending should then prepare for the meeting by reviewing the read-ahead package as discussed in the previous section.

Owner Actions

As with the contractor, the COE must decide what, if any, representatives to send to the meeting. While meeting minutes and any constructability report arising from the symposium are useful, there are many benefits to be gained if designers hear contractor concerns first-hand. Consideration should be given, therefore, to having lead designers attend, as well as key project management personnel.

The COE must also determine its level of involvement in the symposium. The COE may elect to attend merely as passive observers, or may elect to engage in active discussion with the contractor representatives. A middle of the road approach is probably best. COE representatives should at least be prepared to explain various options under consideration, but should probably refrain from debating the relative merits of various proposals so as to avoid adopting a defensive posture and also avoid any potential conflicts with contractor representatives. To avoid hasty

decisions, it may be wise for the COE to state up front that no decisions will be made at the symposium, but rather that the relative advantages and disadvantages of various courses of action will be sought, with decisions to be made at later dates after careful consideration of all relevant factors. Such a statement should reduce the chances of conflicts arising between contractors or between a contractor and the COE.

8.8.3 Conference Phase

Proper Atmosphere

One of the most critical and immediate tasks for the meeting facilitator is to establish the proper meeting atmosphere. The desired atmosphere is one conducive to free and open discussion, free of personal conflicts, with all attendees working together in a cooperative spirit for the benefit of all concerned.

Of course, the groundwork for a successful atmosphere is laid long before the day of the meeting, and includes such things as a quality read-ahead package and proper selection of contractor representatives, as have already been discussed. The physical arrangements such as seating, lighting, food service support, and quality audio-visual aids are equally essential.

To establish a business-like atmosphere, the meeting should start on time. The first order of business should be personnel introductions, as this serves as a means of breaking the ice. Next, the facilitator should review the meeting agenda, review the desired products to be derived from the session, and then provide a brief project overview making maximum use of various graphics such as videotape, photographs, locator maps, and plan views and cross-sections, as appropriate for

the particular project under discussion. Such an overview briefing will refresh the memories of those who have previously studied the read-ahead packet. In addition, there may be representatives in attendance who, for whatever reason, were unable to review the read-ahead package, and such an overview is critical to enabling them to participate meaningfully in the session.

Facilitator Technique

Following the introductions and overview briefing, the facilitator should move on to discussion of the project itself in accordance with the discussion points prepared previously by the members of the study team. The facilitator should guide the discussion through the points, restating conclusions, but taking care not to pass value judgments on either the proposed design or contractor comments or recommendations.

Meeting Management

The meeting agenda should lay out the time for breaks and also the general timeline for discussions. The facilitator should strive to adhere closely to the break schedule, but should adjust topic discussions based on the quality of those discussions.

Breaks are important not only because they allow participants to make telephone calls, use restrooms, or get refreshments, but also because they permit sidebar conversations to explore topics in additional depth.

Documentation

The meeting should not be electronically recorded, as this may inhibit free and open discussion. Notes should, instead, be taken manually. Names, addresses, and phone numbers of all attendees should be recorded, as well as main points of agreement and disagreement. Flipcharts may be useful for summarizing or capturing ideas during brainstorming sessions.

8.8.4 Post-Conference Phase

Meeting Minutes Preparation

Minutes of the symposium should be prepared and distributed to all participants as soon after the meeting as possible. The relative advantages and disadvantages of various options should be listed, as well as major points of agreement or disagreement. Comments should be summarized, and not attributed to specific individuals.

Results Analysis

The results of the symposium must be analyzed following meeting minute preparation. It is likely that there will be significant consensus among the contractors on some issues, and no agreement whatsoever on others. The study team may be able to draw some conclusions or make some recommendations based strictly on contractor comments, while other issues will require further study. Depending on the COE's degree of participation, the owner's viewpoint may not have been adequately addressed in the symposium. As a result, further investigation or discussion with COE representatives may be needed.

Analysis of the symposium results may also identify information gaps that require follow-up calls or visits to contractors or material suppliers. The study director should control follow-up contact with contractors to ensure it is done in a coordinated manner.

Findings and Recommendations

After analyzing meeting results and collecting any additional data needed, the study team should prepare its findings and recommendations in the form of a written report.

As a courtesy to the contractors who participated in the process, the study team should provide copies of the report to all contractors.

Feedback to Contractors

The COE should give the contractors feedback on the points raised in the symposium. This feedback can be in the form of a follow-up meeting or a written report. Whatever form it takes, this feedback should center on what suggestions were accepted and which rejected. The rationale behind rejected suggestions should be explained, as this will foster good relations with the contractors by letting them know that their input was at least considered.

8.8.5 Types of Information That Can Be Obtained

The Sargent Beach constructability symposium demonstrated that such forums are well-suited to collecting contractor input on such things as:

a. General sources of materials

b. Likely modes of transporting or producing materials

c. General sequence of construction activities

d. Types and approximate numbers of construction equipment required

e. Contractor preferences concerning government-furnished items

f. Quality control standards

g. Contract scopes and packaging

h. Potential sources of claims and disputes

i. Preferred method of dispute resolution

j. Constructability of the proposed design

k. Bid bases

l. Suitability of partnering

The study revealed that such symposiums are not well-suited to getting such information as:

a. Detailed activity logic or durations

b. Equipment cycle times

The reason that these items cannot be collected is that the symposium participants are not likely to have sufficiently detailed knowledge of the project. Also, such information is usually painstaking to put together. To attempt to do so would risk bogging down the group in too much detail and is not recommended.

8.9 Conclusions Concerning COE Constructability Methods

As a result of the experience gained during the Sargent Beach constructability study, it is concluded that:

1. The COE's existing system for design review does not afford adequate opportunity for construction contractor input to the project planning and design process.

2. The constructability symposium technique is an effective means of soliciting construction contractor input into the project planning and design process.

3. The COE benefits from a constructability symposium by:

   a. Developing contractor interest in the project

   b. Gaining feedback on the proposed design or contracting strategy

   c. Improving its relationship with contractors by demonstrating a willingness to change and by considering the contractor's point of view.

4. The contractors who participate in a constructability symposium benefit by:

   a. Getting a lead on potential new work

   b. Helping to produce what should be a more constructable design, which will benefit the contractor who gets the contract

   c. Interacting with other contractors.

5. No one public sector constructability technique is suitable for all projects. The particular method selected depends on the characteristics of the project under consideration.

8.10 Recommendations Concerning COE Constructability Methods

In light of the Sargent Beach constructability study, the following recommendations are offered for consideration by the COE:

1. That the COE incorporate the constructability techniques described in this thesis into the project development process. The particular technique to be employed on any one project should be a function of the circumstances surrounding that project.

2. That the COE test its ability to attract qualified construction contractors to a constructability symposium by means of public advertising.

3. That COE districts designate a constructability manager to coordinate and oversee district constructability efforts and capture lessons-learned.

4. That any constructability efforts be in addition to, and not replacements for, the existing project reviews that are performed on COE projects.

5. That after completion of a sufficient number of projects on which constructability techniques have been employed, project performance be compared between "constructability" and "nonconstructability" projects in an attempt to quantify benefits, if any.

8.11 Applicability to Other Public Sector Entities

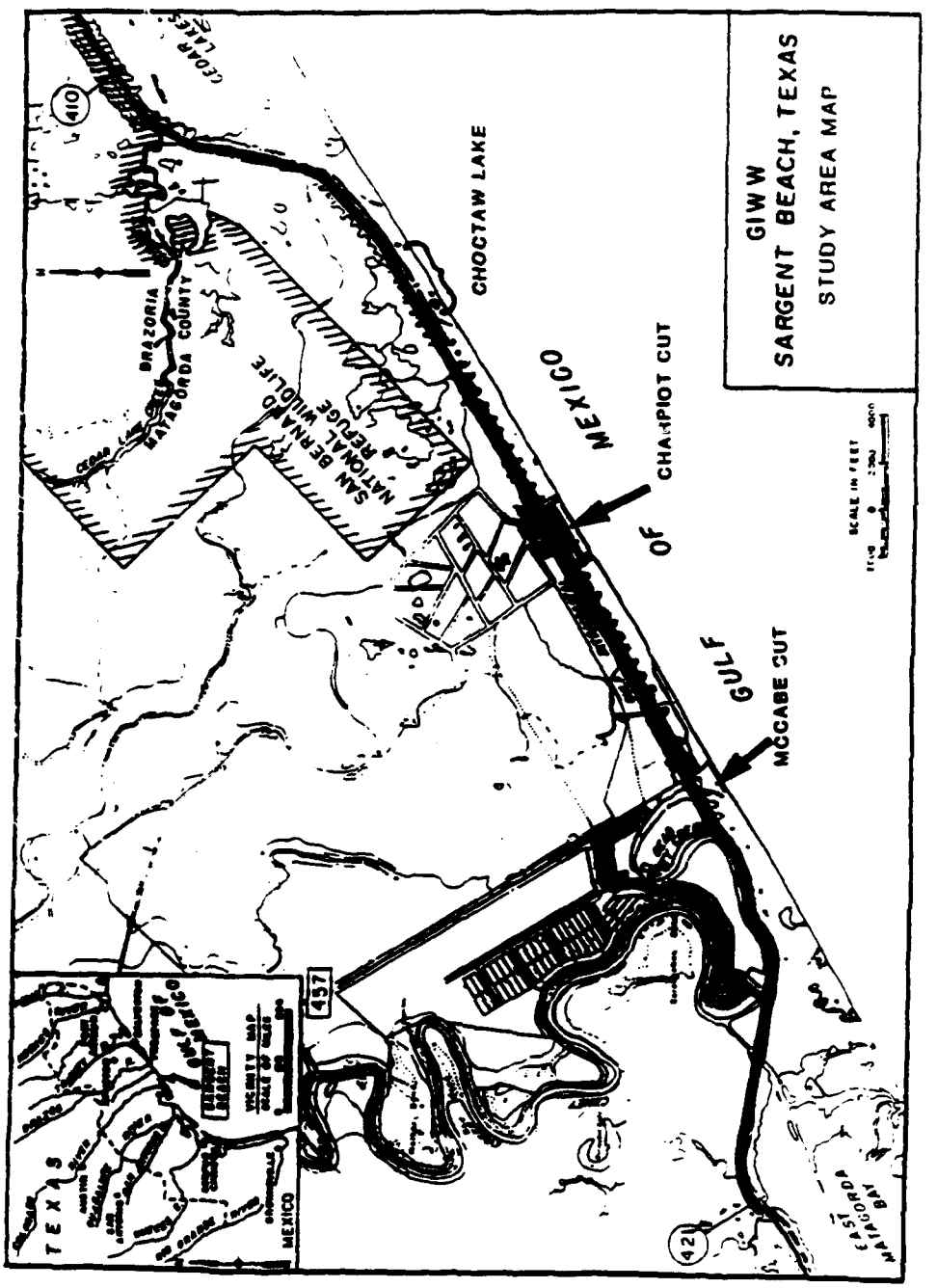
There is nothing about the constructability symposium or any of the other constructability options described here that would appear to limit their use to the US Army Corps of Engineers. Other public sector owners, therefore, should be able to use the techniques to gain construction contractor input into the project planning and design process as well.

APPENDICES

APPENDIX A:

STUDY AREA MAP

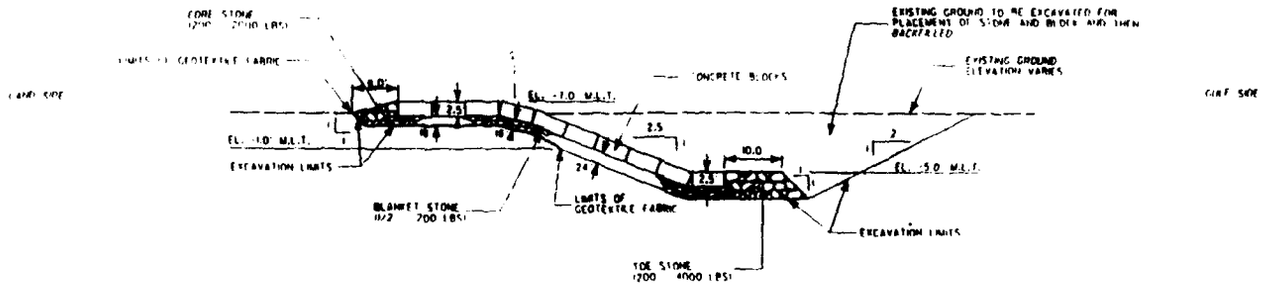
(COE 1992. GIWW Section 216 Study)


GIWW
SARGENT BEACH, TEXAS
STUDY AREA MAP
CHOCTAW LAKE
MEXICO
OF
GULF
CHANNEL CUT
MCCABE CUT
SAN BERNARD NATIONAL WILDLIFE REFUGE
BRAZORIA COUNTY
MATAGORDA COUNTY
CEDAR LAKE
EAST MATAGORDA BAY
TEXAS
MEXICO
SCALE IN FEET
457
410
421

APPENDIX B:

CROSS SECTIONS OF PROPOSED STRUCTURE

(Tomlinson 1993. "Memorandum")



TYPICAL IV:2.5H CONCRETE BLOCK REVETMENT

STA. 20+00 TO STA. 73+60
STA. 108+00 TO STA. 333+00
STA. 368+50 TO STA. 410+00

SCALE IN FEET
10 0 10

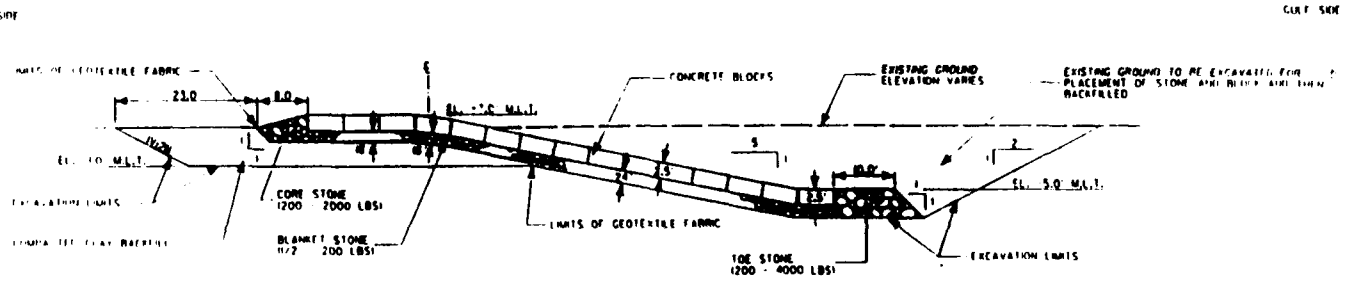
GULF INTRACOASTAL WATERWAY, TEXAS
SARGENT BEACH

TYPICAL CROSS SECTION

U. S. ARMY ENGINEER DISTRICT, GALVESTON

DATED: 22 FEB 91

PLATE



TYPICAL IV:5H CONCRETE BLOCK REVETMENT

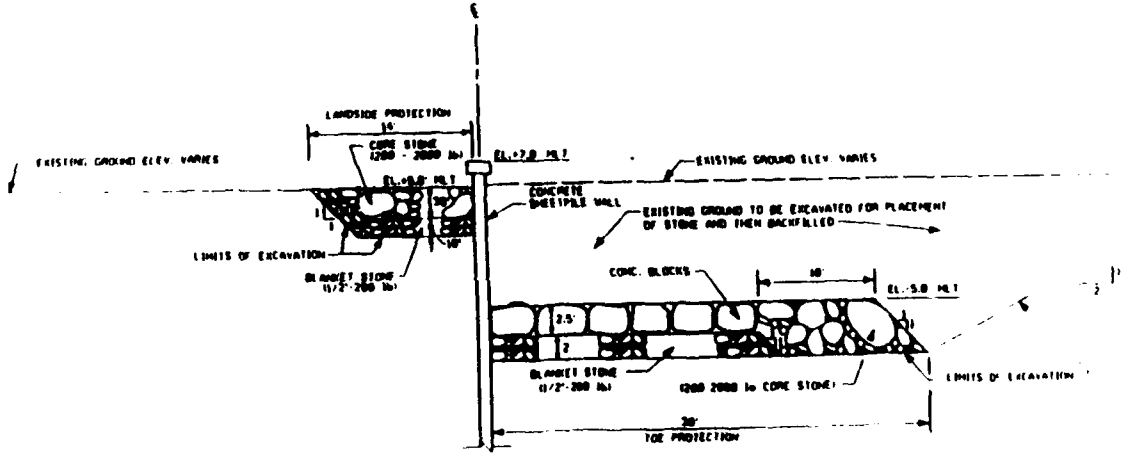
STA. 340+80 TO STA. 368+50

GULF INTRACOASTAL WATERWAY, TEXAS
SARGENT BEACH

TYPICAL CROSS SECTION

U. S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS

DATED: 22 FEB 93



CONCRETE SHEETPILE WALL

STA. 77+00 TO STA. 107+00
STA. 332+00 TO STA. 356+00

SCALE IN FEET

GULF INTRACOASTAL WATERWAY, TEXAS
SARGENT BEACH

CROSS SECTION OF
CONCRETE SHEETPILE WALL

U. S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS

TO ACCOMPANY
ENGINEERING APPENDIX
DATED: FEBRUARY 199.

APPENDIX C:

SCOPE OF WORK OF CONSTRUCTABILITY STUDY AS DETERMINED BY THE COE AND CII

(CII 1993)

3 November 1992

SUBJECT: Sargent Beach, Texas, Scope of Work for the Constructability Purchase Order.

1. Construction Contracting Methods

a. Scope of each construction contract.
b. Duration of each construction contract.
c. Number of construction contracts.
d. Award dates and staggering of contracts.

2. Construction Processes

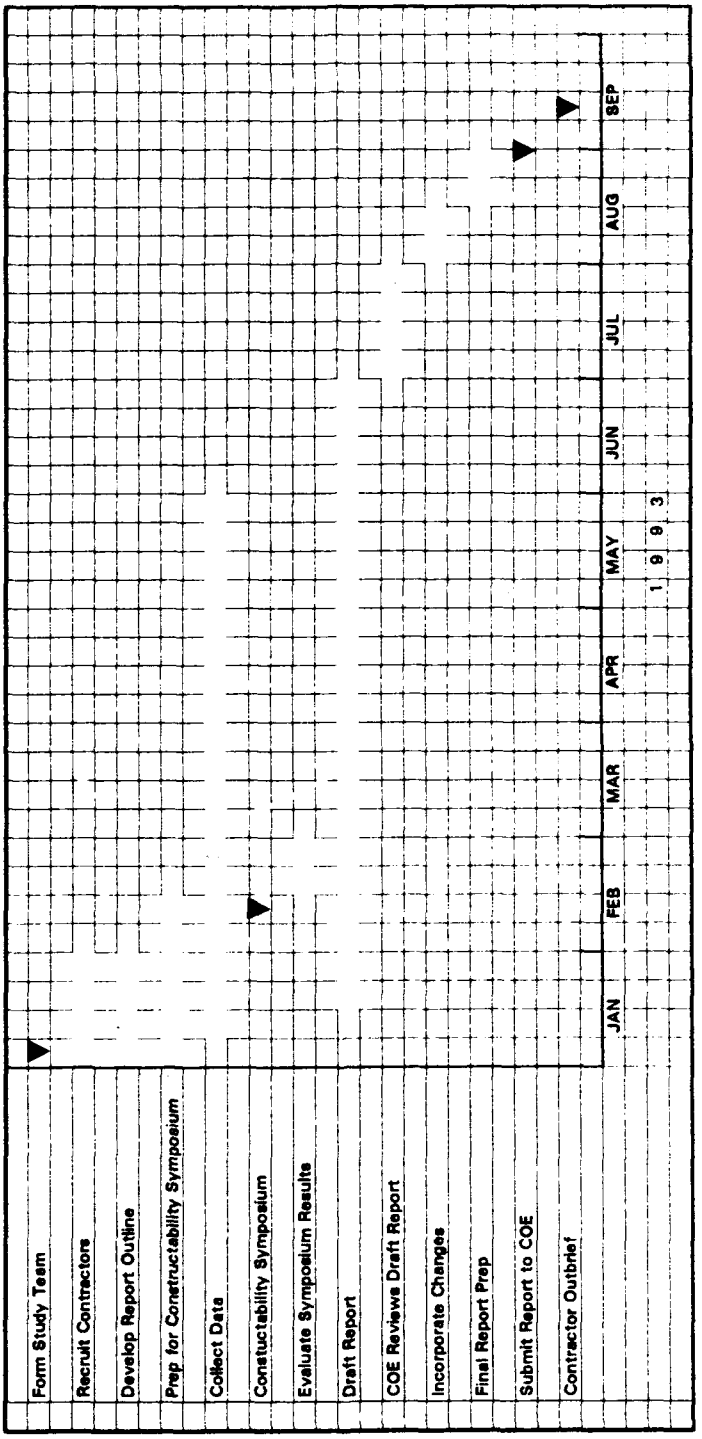
a. Reconfiguration of armor, sheetpile, or other materials in order to enhance construction productivity.
b. Investigation into construction equipment innovations that will increase productivity.
c. Logistics.
    1) Sizing, number, and location of mooring facilities.
    2) Sizing, number, and location of staging areas.
    3) Sizing and location of haul roads.
d. Order of work, both micro and macro.
    1) Describe the pile driving operation and revetment placement operation in a step-by-step manner including order of work, production rates, type and size of equipment, crew sizes, and the work area required on both the landward and shoreward sides of the structures centerline.
    2) Describe any potential risks or problems that can be expected to be encountered by the contractor and the resulting affect on the production rate.
e. Risk management.
    1) Should mooring facilities be permanent or temporary?
    2) Should mooring facilities be constructed under a contract to be awarded in advance of the main construction contract(s)?
    3) Should staging areas be part of mooring facilities contract(s)?
    4) Should the haul road be part of the permanent structure?
    5) Should the haul road be constructed in whole or in part under a contract to be awarded in advance of the main construction contract(s)?
f. Detailed logic diagram and CPM schedule.
g. Time reduction study.

3. Other Recommendations as Appropriate

a. ADR provisions.
b. VE type suggestions.
c. Contracting strategy recommendations.

APPENDIX D:

CONSTRUCTABILITY STUDY SCHEDULE


Form Study Team
Recruit Contractors
Develop Report Outline
Prep for Constructability Symposium
Collect Data
Constuctability Symposium
Evaluate Symposium Results
Draft Report
COE Reviews Draft Report
Incorporate Changes
Final Report Prep
Submit Report to COE
Contractor Outbrief
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
1 9 9 3

APPENDIX E:

INVITATION TO CONSTRUCTABILITY SYMPOSIUM

(CII 1993)

COLLEGE OF ENGINEERING

THE UNIVERSITY OF TEXAS AT AUSTIN

Construction Industry Institute

3208 Red River Street, Suite 300 • Austin, Texas 78705-2650 • (512) 471-4319 • FAX: 512-499-8101

M E M O R A N D U M

To: Dick Bryan, H. B. Zachry
John Carrigan, T. L. James 7 Co., Inc.
Jim Carroll, Morrison Knudsen Co., Inc.
Bruce Hogge, Brown & Root
Dennis Pullar, Guy F. Atkinson
Bill Shaw, Luhr Bros., Inc.
Ancil Taylor, Bean Dredging Corp.

From: Charles I. McGinnis
Construction Industry Institute

Date: January 13, 1993

Subject: Sargent Beach TX Project

1. The proposed meeting to discuss the Sargent Beach, TX Corps of Engineers project has been scheduled from 8 a.m. until 4:30 p.m. on Friday, February 12, 1993. We will meet at the Houston Intercontinental Airport Marriott Hotel in the "Matagorda" Room.

2. A special room rate of $65.00 per night will be available until January 29th. Contact the hotel at (713) 443-2310 to make your reservations. Don't delay, as rooms may not be available later, and even if available, they will cost more.

3. CII will provide a continental breakfast in the meeting room at 7:30 a.m., break refreshments and lunch.

4. The meeting purpose will be to:
   a. Inform those present about the project.
   b. Identify and review constructability and construction methods options.
   c. Discuss preferred contracting strategy and risk allocation options.
   d. Identify and review preferred logistics support options.
   e. Suggest design alternatives, if applicable.

5. To assist us in planning, please indicate below the number of people you plan to have attend.
   a. Number staying at the hotel; on Thurs., 2/11? _____
   B. Number attending the meeting on Friday, 2/12? _____

6. Additional project information will be sent in advance of the meeting to permit preparation for an intensive and productive day together. Please phone or fax your response to questions in paragraph 5 on/or before January 29th. The CII fax number is (512) 499-8101 and the phone number is (512) 471-4319.

7. We appreciate your interest in the project and your willingness to participate in this noble experiment.

CIM:dr

APPENDIX F:

CONSTRUCTABILITY SYMPOSIUM FACILITATOR'S GUIDANCE PACKAGE

(CII 1993)

AGENDA ITEM 6: PROJECT MATERIALS

1. Stone cost/location/production and delivery rates, transportation systems available?
   a. Core
   b. Blanket
   c. Cut armor units
   d. Concrete aggregates--point of use?
   e. Road metal
   f. Rail ballest
2. Cost block vs quarry stone for armor units
3. Surge storage requirements--quantity, location, equipment?
4. Geotech fabric type, source, cost?
5. Range of in-place blanket stone costs--graded vs uncontrolled gradation?
6. Casting yard location/cost/production rates
   a. Blocks
   b. Sheet piling
7. Plan for providing concrete at job site?
8. Other as developed in the conference?

AGENDA ITEM 8: TRANSPORTATION AND HANDLING

1. Transport options discussion--type, relative cost, cycle time rates, re-handling requirements
   a. Mainland
   b. Water
   c. Island

2. Haul cycle scenarios
   a. Rail - barge - rail
   b. Rail - piggy back barge - rail
   c. Truck - barge - rail
   d. Truck - barge - truck
   e. Truck - piggy back - truck
   f. Truck - barge

3. Haul unit capacities by material type
   a. Truck (island)
   b. Rail (through)
   c. Rail (island)
   d. Barge - piggy back
   e. Barge - bulk

4. Water transport requirement?
   a. Number of units
   b. Unit configuration

5. Island mooring facilities
   a. Number
   b. Approximate location
   c. Approximate size
   d. Special requirements

6. Problems/concerns regarding GIWW
   a. Crossing
   b. Traffic control
   c. Accident risk
   d. Wave wash control

7. Materials handling equipment requirements?

8. Transport cycle time estimates - source to site terminal

9. Cost and time estimates on island

a. Road
b. Rail
c. Water based

10. Equipment availability?

11. Transport contingency plans
    a. On water
    b. On land
    c. Weather influence

12. Contract terms
    a. Government furnished
    b. Mobilization item
    c. Incorporated in contract

AGENDA ITEM 9: WORK SITE OPERATIONS

1. Work face sequence
   a. Dimensions of work area along center line
   b. Cycle sequence, timing
   c. Concurrency of operations
   d. Plan for unusual sections
   e. Plan for select fill placement

2. Horizontal and vertical control requirements

3. Simultaneous work faces--starting points

4. Real estate adequacy

5. Excavation
   a. Dewatering requirements
      (1) By design reach?
      (2) By operation performed?
      (3) How accomplished? Cost?
      (4) Design options to avoid?

   b. Equipment proposed
      (1) Capacity, availability?
      (2) Cycle time
      (3) Site transport
      (4) Maximum availability

   c. Weather influence
   d. Quality control
   e. Spoil pile location?
   f. Bank stability

6. Geotech placement technique?

7. Quality control plan

8. Backfill

9. Sheet pile section
   a. Design
   b. Placement

10. Choke points?

11. Design suggestions

12. Special equipment applications?

13. Probable maximum manning level

14. Key safety concerns

15. Seasonal influence

16. Permits required
    a. Barge terminal construction
    b. Heavy loads
    c. Waste disposal

17. Support facility requirements
    a. Aircraft landing
    b. Water, power, fuel, equipment maintenance
    c. Waste disposal
    d. Casualty treatment/evacuation
    e. Crew accommodation
    f. Service road
    g. Weather shelters

AGENDA ITEM 11: CYCLE TIME

1. Macro - unit size
   a. Material sources
      (1) Quarry
      (2) Pre-cast
      (3) Concrete
      (4) Geotech fabric
      (5) Other
   b. Transport means to job site
   c. Transport to work face
   d. Equipment return

2. Micro - unit rates
   a. Material receipt
   b. Island transport
   c. Site operations
   d. Transport return

3. Contingency management
   a. Off island transport interruption
   b. Transport delays
   c. Unloading delays
   d. Island transport breakdown
   e. Manufactured material flow interruption
   f. Weather restrictions
   g. Slope failure
   h. Dewatering failure
   i. Excavation/placement equipment failure
   j. Permit delay
   k. Quality control failure
   l. Temporary facility failure
   m. Other

AGENDA ITEM 12: RISK ASSESSMENT

1. Issues related to working Corps projects--positive and negative

2. Issues related to Galveston District in particular

3. Risk factor intensity, preferred assignment:
   a. Weather - wind speed, wave damage
   b. Barge transportation failure
   c. Production failure
   d. On-land transport and handling failure
   e. Environmental challenge
   f. Contractor interference
   g. Labor strife
   h. Supplier/subcontractor default
   i. Differing site conditions
   j. Design error/omission
   k. Other work stoppage basis

4. Risk mitigation
   a. Provisions for weather emergency evacuation
   b. Accidents
   c. Equipment failure

5. Preferred Corps pre-work
   a. Test piles
   b. Line and grade monuments
   c. Barge terminals
   d. Haul road
   e. Utility provision
   f. Permits
   g. Dewatering
   h. Material source designation

6. Insurance/risk management plan

7. Subcontractor bonding

AGENDA ITEM 13: PROJECT CONTROLS

1. Contracting strategy
   a. Pre-work
   b. Government furnished
   c. Prime contracts
   d. Subcontracts
   e. Award timing, sequencing
   f. Bid period
   g. Bid basis - LS, unit price
2. Optimum milestone events
3. CPM schedule scope--number of activities
4. Acceleration potential
5. Ownership of float
6. Mobilization period
7. Liquidated damages/incentives
8. Partnering assessment
9. Disputes Review Board--other ADR
10. Comment on simulation

APPENDIX G:

CONSTRUCTABILITY SYMPOSIUM AGENDA

(CII 1993)

SARGENT BEACH, TEXAS
CONSTRUCTABILITY SYMPOSIUM
February 12, 1993

AGENDA

8:00 a.m.	1. Welcoming Remarks
8:05 a.m.	2. Introductions
8:20 a.m.	3. Meeting Objectives a. Purpose b. Products
8:25 a.m.	4. Meeting Plan Discussion
8:30 a.m.	5. Project Briefing a. Overview b. Recent Design Changes c. Pre-Construction Schedule Milestones d. Questions
9:00 a.m.	6. Project Materials
9:45 a.m.	7. Break
10:00 a.m.	8. Transportation and Handling
11:00 a.m.	9. Work Site Operations
12:00 noon	10. Lunch
1:00 p.m.	11. Cycle Time a. Micro b. Macro
2:00 p.m.	12. Risk Assessment
2:45 p.m.	12a. Break
3:00 p.m.	13. Project Controls
4:00 p.m.	14. Plus/Delta Analysis
4:15 p.m.	15. Concluding Remarks
4:30 p.m.	16. Adjourn

APPENDIX H:

CONSTRUCTABILITY SYMPOSIUM MEETING PLAN

(CII 1993)

SARGENT BEACH, TEXAS
CONSTRUCTABILITY SYMPOSIUM
February 12, 1993

MEETING PLAN

PURPOSE:

To inform potential bidders about the Sargent Beach, Texas project, and to collect construction methods, constructability, contracting strategy, and risk allocation suggestions from them.

IN A WAY THAT:

Encourages the free exchange of facts, ideas, and opinions.

SO THAT:

- o Construction knowledge is exploited in the final project design.
- o Contract terms are made as fair and attractive as possible.
- o Optimum value is obtained for the U.S. taxpayer through project execution.
- o Interested contractors become familiar with the project and its purpose at an early planning stage.
- o Competition is encouraged.

APPENDIX I:

CONSTRUCTABILITY SYMPOSIUM MEETING PRODUCTS

(CII 1993)

SARGENT BEACH, TEXAS
CONSTRUCTABILITY SYMPOSIUM
February 12, 1993

MEETING PRODUCTS

1. Facts upon which to base computer model studies relating to:
   a. Material options--type, source, cost, quality, production rates
   b. Transport options--type, reliability, availability, cost, risk, cycle time
   c. Material handling options--equipment requirements, cycle time, re-handling requirements, unloading sites
   d. Site operations--working faces, placement rates, equipment requirements, re-handling, quality control, cycle description and timing
2. Contracting strategy
   a. Number of contracts
   b. Extent of site preparation desired
   c. Payment options
   d. Dispute resolution
   e. Incentives
3. Risk allocation
   a. Storm damage - protection
   b. Quantity variation
   c. Construction methods
   d. Geotech conditions
   e. GIWW availability
4. Project controls
   a. Scheduling
   b. Sub-contracting
   c. Quality assurance/quality control
   d. Safety
5. Other recommendations to:
   a. Optimize costs
   b. Stimulate qualified competition
   c. Assure timely completion

APPENDIX J:

CONSTRUCTABILITY SYMPOSIUM MEETING MINUTES

MEMORANDUM FOR RECORD

FROM: John E. Wood and W. Scott Flanigan

DATE: 9 March 1993

SUBJECT: Constructability Symposium For The Sargent Beach Study, Held 12 February 1993.

1. The purpose of this memorandum is to document the results of the constructability symposium held at the Houston Intercontinental Airport Marriott Hotel, San Jacinto Room, on Friday 12 February 1993 from 0800 - 1600 hours concerning the Sargent Beach Constructability Study.

2. Those in attendance at the meeting were:

Name	Company	Telephone #	Address
MG Charles McGinnis	CII	# 512-471-4319	3208 Red River St. Suite 300 Austin, TX 78705
Dr. Koshy Varghese	Univ. of Texas / CII	# 512-471-1620	Dept. of Civil Engr. ECJ 5.200, Austin, TX 78712
Cpt Scott Flanigan	Univ. of Texas	# 512-471-4648	Dept. of Civil Engr. ECJ 5.200, Austin, TX 78712
Cpt John Wood	Univ. of Texas	# 512-471-4648	Dept. of Civil Engr. ECJ 5.200, Austin, TX 78712
Mr. Curtis Stefferud	Univ. of Texas	# 512-471-1620	Dept. of Civil Engr. ECJ 5.200, Austin, TX 78712
Mr. Hatem Goucha	Univ. of Texas	# 512-471-4648	Dept. of Civil Engr. ECJ 5.200, Austin, TX 78712
Mr. John Cleveland	Corps of Engineers	# 409-766-3089	PO Box 1229 Galveston, TX 77553
Mr. Mike McClenan	Corps of Engineers	# 409-766-3977	PO Box 1229 Galveston, TX 77553
Mr. Richard Tomlinson	Corps of Engineers	# 409-766-3171	PO Box 1229 Galveston, TX 77553
Mr. Mike Villeneava	Corps of Engineers	# 409-766-6377	PO Box 1229 Galveston, TX 77553
Mr. Jim Van Norman	T.L. James & Co. Inc.	# 713-452-3373	PO Box 956 Channelview, TX 77530
Mr. Steve Spohrer	T.L. James & Co. Inc.	# 504-461-9356	PO Box 20115 New Orleans, LA 70141
Mr. Frank Denton	T.L. James & Co. Inc.	# 504-461-9310	PO Box 10 Kenner, LA 70063
Mr. Harlon Fowler	Brown & Root, Inc.	# 713-676-7481	PO Box 3 Houston, TX 77001
Mr. Harold Horne	Brown & Root, Inc.	# 713-676-4638	PO Box 3 Houston, TX 77001
Mr. Dana Strebeck	Brown & Root, Inc.	# 713-676-4209	PO Box 3 Houston, TX 77001
Mr. William Gardner	Luhr Bros., Inc.	# 618-281-4106	PO Box 69 Columbia, IL 62236
Mr. William Shaw	Luhr Bros., Inc.	# 618-281-4106	PO Box 69 Columbia, IL 62236
Mr. Jack Seward	Luhr Bros., Inc	# 409-233-2224	PO Box 937 Freeport, TX 77541
Mr. James Stockstill	C.F. Bean Corporation	# 504-391-7000	PO Box 237 Belle Chase, LA 70037
Mr. Glen Ashy	C.F. Bean Corporation	# 318-234-4501	PO Box 51657 Lafayette, LA 70505

Mr. Yale Lyman	Guy F. Atkinson Co.	# 415-876-1328	10 W. Orange Ave. S. San Francisco. CA 94080
Mr. Stephen Maynard	H.B. Zachry Co.	# 713-933-9993	PO Box 722250 Houston. TX 77272
Mr. Wayne Sutherland	Morrison Knudsen	# 208-386-5000	PO Box 73 Boise. ID 83729

3. MG McGinnis started the meeting at 0800 hours with welcoming remarks and brief introductions of the CII/University of Texas research team. The floor was then open for each individual attending the meeting to briefly introduce themselves and state which company they were representing and what position they held.

4. MG McGinnis discussed the purpose of the meeting and what products he hoped would result from the symposium. He then reviewed the meeting agenda and asked for any suggestions to improve the meeting plan (no suggestions were given).

5. MG McGinnis then presented a project briefing, in the form of a slide show, to those in attendance. The slide show provided a good overview of the project area and gave a good explanation of why the study is important. The design features of the revetment and sheet pile wall were briefly discussed as well as the addition of the geotextile fabric.

6. MG McGinnis asked for any questions concerning the project briefing slide show. The following questions were asked:

Q1: How was this project selected by the Corps of Engineers (COE)?
A1: This project seems to have good potential for the application of constructability concepts and the ability to try new concepts.

Q2: What is the availability of sand for beach renourishment?
A2: Beach renourishment was considered in the feasibility study and was found to be too expensive.

Q3: The COE used a similar design on the Spillman Island Project (vic. Houston); however, they used quarried rock in a rubble effect instead of armor units. Why not use a rubble design on this project?
A3: The design of the armor units has undergone testing at the Waterways Experiment Station and found their size and density to be most effective given the life of the project (50 years). The shape and weight of the armor stone provide the stability needed to undergo the constant wave action from the Gulf. With graded quarry stone there is a high likelihood that the wave action would move or damage the protective structure.

Q4: Why construct the revetment only 300 feet from the GIWW?

A4: 300 feet is the minimum buffer which must be maintained between the GIWW and the Gulf. If construction were to take place closer to the Gulf, unexpected storms could increase erosion rates and affect the project by making construction take place under wet conditions (i.e., wave action). The objectives are to protect the GIWW and permit construction to take place under the most favorable conditions possible.

7. Following the introductions and project briefing, the discussion shifted to the agenda items in order to gain feedback from the contractors on the proposed design.

8. Issue: **Sources of Core and Blanket Stone**

a. St. Genevieve or Cape Girardeau, Missouri are possible sources for the core and blanket stone. Several other sources exist along the Ohio River as well. Projects in the southeastern US and Gulf Coast region rely primarily on these sources.
b. The gradation of the stone has not been a significant concern in the past; the majority delivered is within the specifications needed. The type of stone delivered is predominately dolomite.

9. Issue: **Sources For Stone Armor Units**

If a quarry stone is used for armor units, then the most probable source to meet the granite size requirement is Marble Falls, Texas. The granite at that location usually ranges from 4-6 tons; therefore, the required 6 ton armor unit is at the upper limits of the scale. This alternative might not be cost effective and will probably not be able to compete against the precast concrete option.

10. Issue: **Equipment For Handling The Armor Units**

a. For the large granite a rock grapple weighing 3 - 5 tons will work effectively.
b. For the precast concrete units, a lifting eye might be precast into the unit, therefore allowing the unit to be picked up by a crane. A rock grapple can also be used effectively with the concrete units.

11. Issue: **Acceptance/Rejection Criteria For Armor Units**

a. It is to be expected that the armor units, be they stone or precast concrete, will be knocked around somewhat during shipment and placement, and that some chipping, cracking, or other damage will occur. A significant concern was that

reasonable acceptance/rejection criteria be established. Unreasonable criteria will significantly increase the cost of the project.
b. The Corps is more concerned with functionality than appearance, since the majority of the units will be buried initially. A reasonable standard for surface finish of the revetment would be +/- one foot. A smaller tolerance (1-6 inches) would be difficult to meet and would increase costs significantly.
c. The critical issues which should be addressed in the contract documents include the acceptable levels of damage which the armor units can undergo before rejection and the grade control for stone placement.

12. Issue: **Construction Using Floating Equipment (i.e. the "Wet Method")**

a. One construction method considered involved cutting access channels from the GIWW into the middle of the island, making the required excavations using dredging equipment, and placing the core and blanket stone and armor units directly from the barges used to transport them to the project site. This method came to be called the "wet method" for building the project, since construction would be done largely underwater using floating equipment.
b. One contractor felt that by taking the material directly off the barge and placing it into final position, the handling and installation costs could possibly be reduced by half.
c. The channel would be excavated with the use of floating dredge equipment. A bucket dredging apparatus would operate directly off a barge and would place the excavated material on the Gulf side of the structure.
d. The rock barge has an average dimension of 35 feet wide by 195 feet long and requires a 9 foot draw. The barge used for the unloading equipment has an average width of 40 feet and requires a 5 foot draw. Therefore, the channel cut would require a minimum width of 80 feet and might be as wide as 100 feet.
e. If a channel were to be dredged for barge traffic, then the 300 foot ROW would probably have to be expanded.
f. If this method of construction is permitted (excavated channel cut), then the contractor should be given the freedom to choose how the excavation should take place, as this might help generate competition. All too often a contractor's hands are tied as to the method of construction because of procedural specifications.
g. If a channel cut is used to deliver materials and construct the structure, then additional access channels may be needed from the GIWW. It was recommended that the channel have an access cut every 2500-5000 feet with a width of 60-70 feet. If this plan is selected, there may be significant real estate implications.
h. If access channels are cut, then they must be closed using sheet pile or some type of revetment design. It may require a revetment which has stone slope protection on both sides (trapezoidal design).

i. Some of the problems associated with this method include real estate acquisition for rights-of-way, and the possibility of cutting the access route to existing houses. It was recommended that the existing road remain intact and that access channels be provided at either or both ends of the road.

13. Issue: **Location of Concrete Casting Yard**

a. No consensus was reached as to whether the prime contractor would set up his own casting yard for manufacture of precast concrete armor units or use existing precast plants as suppliers.
b. The contractors agreed that the only economical means of transporting the precast armor units would be by barge.
c. The consensus was, then, that the casting yard would be located in the vicinity of an existing port, such as Freeport or Houston, regardless of who was running it, prime contractor or supplier.

14. Issue: **Methods of Manufacturing Precast Armor Units**

a. The cheapest method is to place the concrete in a form on a base and ensure that a lifting device is included. The types of lifting devices might include a lifting eye, wire loops, or the most preferred method, a hole placed all the way through the concrete with a pipe. This will allow for lifting during future maintenance operations, as opposed to a lifting eye which will eventually corrode.
b. The 6 ton armor units should have a recommended strength of 3500 psi and should contain sulfate resistant cement. The armor unit specifications should be of standard design with no exotic cement requirements.
c. In general, the contractor should have the ability to use admixtures, superplasticisers, or whatever method current technology has introduced as long as it meets the design specifications.
d. The aggregate used in the concrete armor blocks should be commercially available, preferably the standard 2 inches and below. It was also suggested that the concrete should have hard stone in it to prevent possible erosion from the salt/sea water. Typical river run rock should be sufficient for the concrete with a suggested source located in Victoria, or anywhere along the Colorado River.

15. Issue: **Sources For Concrete Sheet pile**

A possible source for concrete sheet piling is Texas Concrete.

16. Issue: **Design of Service Road**

a. River run stone will probably work effectively. Builders of similar roads in Louisiana are finding crushed limestone to work best. A geotextile fabric should be incorporated into the service road design.
b. The road should be designed wide enough to handle truck mounted cranes with outriggers employed, since it is assumed that these cranes will be needed for periodic maintenance or repairs on the revetment.
c. It was suggested that the splash apron be extended enough to construct the service road right on top. The splash apron blocks could be choked with additional limestone.

17. Issue: **Curing Time and Specifications for Precast Blocks**

a. The length of time that precast concrete armor units must cure before they can be moved should be left to the contractor's discretion. The contractors prefer performance specifications so as to have maximum flexibility to use new techniques. The contractor wants to know what the block should look like and any other mandatory design requirements (COE responsibility); then let them handle the details on how to construct and move the armor units.
b. Since the majority of the blocks will be buried, finishing or texturing on the block will probably not be required. If texturing is required, procedural specifications are not necessary; the costs associated are relatively small.
c. Special block sizes will probably be needed in transition areas adjacent to sheet pile sections, and possibly also when closing gaps between two work faces.

18. Issue: **Stockpiling Construction Materials**

a. The contractors did not think that this project could be done using just-in-time delivery of the materials; the distances the materials will be traveling and the number of things that potentially could interfere with timely delivery make that approach too risky. Stockpiling materials on site is one means of managing the risk of transport failure, and will be required to some extent.
b. If materials are delivered and unloaded directly off barges, then extra barges can be kept on site to handle stockpile requirements. The "demurrage" limit is 3-4 days at the destination. To control the delivery process, a river control point will be established and barges will arrive about 5-6 at a time.
c. If unloading does not occur directly off the barges, then a storage site will have to be constructed, as the existing soil strength is inadequate for large storage loads. The storage location will require stone to be brought in from outside sources.
d. The 300 foot ROW should provide sufficient area in which to store materials.

e. The contractors prefer to determine their own site locations for materials storage along the length of the revetment ROW, rather than having this dictated to them by the COE.
f. The contractors recommend a 3-4 day supply of materials to be stockpiled at the site. Therefore, wherever the storage location(s) are constructed, they must be capable of holding approximately 300-400 armor units (Dr. Varghese estimated that 70-80 blocks would need to be placed per day), and nearly 20,000 tons of rock (blanket and core stone). The armor units will be stored 1 block high, possibly 2.

19. Issue: **Spoil Disposal**

a. Although excavated material should not pose any significant problems, it should still be addressed in the contract. In the past, the majority of the excavated material goes right back in the hole with very little excess.
b. Excavated material should be stored on the beach (Gulf) side of the structure.
c. It was recommended that the extra backfill simply be graded level so as to provide additional material to help slow down the erosion process.

20. Issue: **Use of Geotextile Fabric**

a. Although not shown on the plans included in the read-ahead packet, geotextile fabric will be used on the project.
b. Transport and procurement of an effective geotextile fabric is not a significant issue since it is an "off-the-self" item, and it can be easily emplaced. Geotextile fabric placement will not be a significant schedule factor during construction.
c. The geotextile fabric comes on a large spool and can be rolled out like a carpet.
d. Overlapping the geotextile fabric at the edges should be sufficient, and much less costly than sewing the adjoining sheets together.
e. In the rolled clay sections, a geotextile fabric is preferred over other methods of soil stabilization such as lime or cement.

21. Issue: **Sheet Pile Wall and Pile Caps**

a. The preliminary design calling for the use of concrete sheet piling generated much heated discussion and considerable concern on the part of the contractors present.
b. The contractors questioned the use of concrete sheet piling instead of steel sheet piling. The proposed design calls for the use of concrete sheet piling instead of steel sheet piling because the COE does not have enough confidence in the life expectancy of steel or coated sheet pile; it is thought that concrete sheet pile will last longer. Aesthetics is a minor factor as well.

c. The COE envisions that the concrete sheet pile wall will be driven first, and then the ground can be excavated to install the toe protection. Many contractors expressed doubt that the piles would stay up without tiebacks. Since the wall is cantilevered and not tied back, surcharging from the GIWW side could cause the wall to collapse unless it is driven deeper. The contractors found the requirement to excavate 14-15 feet below ground, after driving the piles, in order to emplace the blanket stone, core stone, and armor blocks, particularly worrisome. The precise excavation required in the vicinity of the piles would be very time consuming and add significantly to the project cost.
d. Several contractors felt the wall would prove to be extremely costly; another method or design might prove more feasible. Perhaps the stone revetment with a flatter slope and geotextile fabric can replace the sheet pile wall. One representative stated that greatly increasing the amount of stone used or somehow strengthening the soil in the areas of poor foundation conditions was greatly preferred over the concrete sheet piling solution, and that use of concrete sheet piling could conceivably add $2 million to the overall project cost.
e. A precast pile cap will be much cheaper than a cast-in-place cap, and should be considered.
f. If a cast-in-place concrete pile cap is needed, then a batch plant can be set up on a barge and water brought in from an outside source if it is not available on the island.
g. The question was raised as to whether or not the pile cap would require reinforcement, without a definitive answer being given.
h. Given their doubts about the proposed design, the contractors expressed a preference for procedural specifications for the sheet pile wall sections. They felt that this would put the risk for this portion of the work on the COE.
i. Several contractors stated that it was unreasonable to expect that all piles would be driven to the same toe elevation. It is to be expected that some would have to be driven to a lesser depth and then cut off.
j. A slurry wall was not considered a feasible alternative.
k. Several contractors stated that they felt that it may be necessary to jet the concrete piles, and that this would impact on the design. Tiebacks would be required if jetting is necessary.
l. The contractors identified the concrete piling as a potential significant problem area once work got underway and also as a potential source of disputes and claims.

22. Issue: **Materials Transportation Options**

a. Rail-barge-rail or Rail-piggy back barge-rail: When moving a rail car on a barge, the costs increase significantly because payments are required for both the rail car and the barge. In this situation, the barge is "hauling iron and not rocks."

Also, the soil conditions would make it extremely difficult and costly to construct a railroad on the island. Wadsworth is probably the nearest rail facility, and it has limited accessibility by water. The general consensus was that this method was not feasible unless alternate means were prohibited.

b. Barge-direct unloading using excavated channel cut: The location of this project makes it extremely advantageous to use water transportation rather than rail whenever possible. It is much cheaper than rail and is more reliable. In addition, the use of water transportation helps reduce material handling requirements. Barges are capable of delivering the blanket and core stone to either a terminal site or directly to an unloading zone along the channel cut. Armor units would also most likely be transported this way. In addition, if barges are used for direct delivery and construction, then the barges can be used for storage until the material is ready for placement.

c. Swing bridge use: The use of the swing bridge cannot be relied upon. The tide affects the swing bridge and the bridge interferes with traffic on the GIWW when employed.

d. Truck usage: Trucks will be used on the island for some material delivery, but this issue was not discussed in detail. It was mentioned that on previous projects, truck traffic was ruled out because of noise and bureaucratic restrictions. The contractors expressed concern about any such restrictions that would be placed on them on this project. If there were to be restrictions, they emphasized the need to ensure that they were explicitly stated in the bid documents, otherwise this would be a certain source of claims. Restrictions on truck use on the island are not anticipated at this time.

e. The contractors felt there were no significant complications in moving materials from the source location (i.e., quarry) to the island or barge terminal. The suppliers are reliable and deliver large quantities of rock and stone to this area (Gulf region) on a regular basis.

23. Issue: **Barge Terminals on the Island**

a. One contractor stated that barge terminals would not be necessary if excavated channel cuts are used to deliver and construct the structure; the remainder, however, felt that barge terminals on the island would be needed. The general consensus was that a minimum of 1 terminal should be constructed for each contractor, with the optimum number of terminals being 2 (even if using only 1 contractor). Two terminals will assist in the construction and provide some redundancy in the event one of the terminals were closed due to an accident (a sunken barge at the terminal, for example).

b. If more than one contractor is used on the project, then each contractor should be provided with his own terminal or terminals. It is unrealistic to expect that

contractors would share a terminal. Use of shared terminals would increase the COE's burden in scheduling their use and would be a likely source of claims.
c. The average raft has 6 barges and each barge has an average dimension of 35 feet by 195 feet. Therefore, the proposed 50 by 450 foot terminal must be increased in length. The recommended length for the terminal is 800 feet. The proposed 50 foot width of the terminal may not be large enough either. The width of the barge terminal may have to be increased to 80 feet. Another option that would require investigation is to anchor barges on the GIWW, but outside the navigation channel.
d. If terminals are to be constructed, the COE feels that two would be needed on the island. The terminals may be required for future COE operation and maintenance purposes. If the terminal(s) is strictly for the COE's future operation and maintenance needs, then that should be so stated in the contract documents, because the construction contractor may not plan on using a terminal if they are using the excavated channel cut (wet method).
e. There are basically two options for construction of barge terminals on the island: 1) include terminal construction in the scope of the main construction contract, or 2) let a separate contract prior to awarding the main construction contract. Although separate contracts may result in a higher overall cost, the majority of the contractors felt that it would be advantageous for the Corps to issue a separate contract for the terminals and ensure that they are complete prior to awarding the construction contract. The only risk associated with early construction of the terminals is the possibility that they are not complete when the main construction contractor is prepared to begin work. It would be ideal to incorporate terminal construction into a GIWW maintenance dredging contract; however, dredging timing may preclude this.

24. Issue: **GIWW Requirements/Limitations**

The average speed allowed on the GIWW was estimated at 4-5 mph. Traffic control and wake wash were discussed as possible issues to investigate further. The Coast Guard requires that barges not be left unattended at any time. The Colorado River locks on the GIWW may have a difficult time handling a 6-barge raft.

25. Issue: **Equipment Availability**

No problems are foreseen regarding the availability of equipment (i.e., barges, cranes, etc).

26. Issue: **Off-Loading (Dry Method, No Channel Cut)**

a. A rock drag bucket will be used for large materials, while a conveyor system will move the smaller materials into trucks or a storage bank.
b. The trucks used for transport will probably range in size from 25-30 tons (i.e., DJB). Once loaded, the truck will transport the material to a storage area or directly to the site for placement.
c. The storage location will require a crane for loading and unloading.

27. Issue: **Number of Contracts**

a. The general consensus was to recommend one contract. No one said they would not bid the job if it was let as one contract.
b. Use of two contracts would require separate docking facilities, and could cause conflicts with casting plants and quarries. Use of one contract would eliminate the problem of competing for facilities, as well as eliminate that as a potential source of claims or disputes.
c. The expectation is that all the companies involved in the bid process would bid both contracts if two contracts were let.
d. If the Corps chooses to go with two contracts, they should let them separately, at different times. However, the contractor who had won the first contract would be at a significant advantage over other bidders for the second contract.
e. Two contracts would significantly increase the amount of work required by the Corps.

28. Issue: **Work Faces**

a. The contractors prefer to operate only one work face at a time. They would operate two work faces probably only if the schedule required it.
b. The closure between 2 separate contracts/work faces could be difficult and would require good coordination between designers, contractors, and project managers. Special size armor units may be required to provide proper closure. The transition between the sheet pile wall and the revetment may also require a special block design.
c. If the schedule required that two work faces be used, the contractor would probably start in the middle and work outward.

29. Issue: **Excavation and Stone Placement**

a. Excavation will probably be on the critical path because of the large volume of soil that must be excavated (approximately 1.2 million cubic yards).

b. The excavated face should be left open for as short a time as possible. The open face is extremely vulnerable to storms and could result in a break through.
c. On other projects, the COE has used closure specifications which place limitations on the distance and time which an excavated face can remain open. The distance is believed to be 200-300 feet. Unless this specification can be changed, it might have serious implications on the excavated channel method (wet method).
d. To minimize risks, it was recommended that the distance between the head of the excavation and the placement of the armor units be minimized.
e. The specifications for layer placement distances were believed to be 200 feet for blanket stone and 500 feet for toe protection. Toe protection will be the last item placed during the construction sequence.

30. Issue: **Work Conditions (Wet or Dry)**

a. Most of the work is expected to take place under wet conditions (i.e., below a free water surface).
b. In order to conduct construction in the dry, wellpointing may be required.
c. The rolled clay section will require dewatering and could prove to be expensive. Since the elevation of the rolled clay section is only -1 foot MLT, the COE believes a sump pump should be sufficient and that wellpoints should not be required. A bid demonstration of sump pump effectiveness should be provided for the contractors bidding on the job. The sump pump should be tested in several spots along the proposed line of construction. If the sump pump proves to be ineffective, then wellpoints would be required.
d. The equipment recommended for wet condition stone placement includes a rock drag lift or a clam. The equipment can operate from the bank or from a barge.

31. Issue: **Proposed Construction Rights-of-Way (ROW)**

a. If working in the dry, using barge terminals and not an excavated channel cut, then the 300 foot ROW should be sufficient for construction.
b. From the center line (approximately the top of the revetment slope where it meets the splash apron), the ROW extends 185 feet toward the GIWW and 115 feet toward the Gulf.
c. If an excavated channel cut (wet method) is used, then a wider construction easement will probably be needed.

32. Issue: **Benchmark Placement/Survey Control**

The contractors prefer that the Corps place monuments or temporary benchmarks every 1000 feet.

33. Issue: **Quality Control (QC) Plan**

a. The contractors would prefer that the COE not dictate that the contractor's QC team cannot perform any other function. They would prefer that the QC team not be made a totally separate organization, as is required by some COE districts. The supervisory staff should be part of the QC team.
b. The contractors felt that the restrictions placed on the QC team do not improve project quality and only serve to drive up project cost.
c. The Corps should tell the contractor he needs to be responsible for QC, but do not tell him how many people he must use to achieve it.
d. When developing QC specifications, consider the nature of the job (i.e., the majority of the work is going to be buried and subject to wave action which will cause some movement). Ensure that QC requirements provide for a stable structure, but are not unreasonable. The contract must be written with reasonable tolerances.
e. To ensure quality underwater, cross sections will be checked for conformity with specs.
f. The Corps should include partnering as part of the contract package. One contractor stated that partnering *will improve quality much more than an army of* QC personnel.
g. Consistent administration and application of standards from bid to project completion are more important than what the actual numbers say.

34. Issue: **Potential Chokepoints**

a. Because this project relies so heavily on logistics, transportation (particularly water transportation) is probably the biggest area of concern. The availability of transportation equipment is not the problem; interruption causing delivery delay is the major concern.
b. The risk associated with shutdown of a lock upstream is beyond the contractor's control and can become very costly.
c. The entire navigational system is considered to be a choke point. Fog and high water problems can significantly affect the delivery schedule and therefore prove costly.
d. The surge stockpile must be expanded during winter months as a hedge against weather-induced transportation delays in the spring.

35. Issue: **Material Payments**

a. Contractors felt that they should receive at least partial payment for precast armor units at the casting yard.
b. A recommendation was made to pay a certain percentage at the casting yard and an additional percentage upon delivery.
c. The percentages to be paid at various points could be determined under the provisions of a partnering relationship.
d. The general consensus was that the contractor should receive payment for completed blocks at the casting yard equal to 100% of his direct cost of production to that point.
e. An actual set price per block should be pre-determined.

36. Issue: **Special Equipment**

No special equipment is required or desired on this project.

37. Issue: **Safety**

a. No special safety requirements were identified.
b. The biggest safety concerns are expected to be crane safety, due to the fact that numerous cranes will be required on the project, and marine safety, given the fact that water transport and other marine operations are expected to play a large role in the project.
c. The consensus was that the Jones Act would apply to most injury compensation cases on the project and would boost costs.

38. Issue: **Workforce Size**

The workforce on the island during the height of construction was estimated at 25 - 30 people working on one shift. This figure does not include personnel involved in barge transportation, or off-site quarry or casting yard operations.

39. Issue: **Permits**

a. Section 404 permits will be required, at least for construction of any barge terminals on the island or for construction done using the "wet method".
b. Under EPA and/or Texas Water Commission (TWC) rules, the owner will be required to develop and file a plan for stormwater management and erosion control.
c. The contractors' preference is for the COE to develop the plan and get it approved by the EPA and/or TWC as required. The actions to be required of the

contractor in order to comply with the plan should then be detailed in the contract documents upon which bids will be based.
d. If the COE does not develop this plan and get it approved by the appropriate agencies prior to putting the project out to bid, then the contractors will have no way of knowing what will be required of them, and so would have a difficult time incorporating this into their bids. The only alternative would be for them to include a sizable contingency for this work in their bids, which would probably result in higher overall project costs than if the COE developed the plan.
e. The consensus was that the project would get off to a better and faster start if the COE obtained these permits, perhaps concurrently with the real estate acquisition process.

40. Issue: **Support Facilities**

a. No special support facility requirements were identified.
b. Commercial power, telephone, and water sources already available on the island were thought to be sufficient to support the project.
c. No fixed equipment maintenance facility is envisioned. Any required equipment maintenance or repairs would be done at the equipment's location. Equipment requiring extensive repairs would be evacuated off-site as needed.
d. Haul equipment would be parked on the haul road when not in use.

41. Issue: **Calculation of Spoil Bank Location**

a. It was pointed out that a fairly detailed engineering calculation would be needed to determine how far from the edge of the excavation the spoil bank should be located so as to avoid slope failure and slides.
b. The two options for determining this were to have the COE determine this and specify it in the contract documents, or to leave it up to the contractor to determine
.
c. The contractors' preference was to leave it up to them to determine.

42. Issue: **Macro and Micro Cycle Times**

a. The logic diagrams used thus far in the computer modeling by CII were reviewed with no suggested changes noted.
b. No cycle times were offered. The recommendation was to use the Caterpillar handbook, but to reduce the production rates listed there somewhat, as the consensus was that the handbook was overoptimistic.

43. Issue: **Maintaining Equipment Stability**

Mats would probably be required underneath cranes, excavators, and other equipment in order to maintain stability while working, given the generally poor soil conditions found on the project site.

44. Issue: **Heavy Equipment Required**

For a contractor using the dry method, the following equipment, as a minimum, would be required:

- 1 dragline excavating the hole for the revetment and casting the spoil aside
- 1 dragline or hydraulic excavator placing the blanket stone
- 1 dragline placing the core stone
- 1 crane placing the armor stone
- 1 dragline backfilling the excavation

45. Issue: **Labor Source**

a. The expectation is that all labor would be brought in for the project, with little if any local labor used.
b. No contractors envisioned establishing a work camp or using crew barges.

46. Issue: **Weather-Related Risk**

a. Four cost items associated with weather-related shutdowns were identified:

- Cost of moving equipment off the island or to a safe harbor
- Cost of overhead expenses during a shutdown
- Damage to completed work
- Damage to work in process

b. It was generally agreed upon that, given an estimated 3 year construction period and the project location, the problem of a project shutdown due to a weather-related event such as a hurricane was likely to be encountered.
c. One guideline offered for determining who should bear the risk was "If a contractor can't reasonably obtain insurance for it, it should be force majeure".
d. The contractors felt that the owner should bear the risk for damage to completed work. Making the contractor bear this risk will lead the contractors to include a hefty contingency for this item in their bids, thus meaning that the owner will definitely pay for this whether damage is incurred or not, whereas having the owner assume this risk up front means that the owner will only pay for it if it actually occurs.

e. The contractors also felt that the owner should bear the risk of damage to work in process.
f. The issue of who should have the responsibility for ordering a project shutdown due to an impending weather threat (i.e. hurricane, tropical storm, etc.) was discussed at great length. Having the COE responsible for ordering a project shutdown would open the COE up for liability if a shutdown was ordered too late and damage to a contractor's equipment, etc. was incurred as a result. Shutting the project down too early would also entail significant costs and could constitute disruption.
g. One option for dealing with this problem is to let the contractor assess the risk of weather-related shutdowns and include this in his bid. This would also entail making the contractor responsible for deciding when to leave or shut down the project.
h. A second option for dealing with this problem is to have contractors include weather-related mob/demob, shutdown, and repair costs as bid items.
i. A third option is to specify in the contract documents that weather-related damages/costs will be paid on a time and materials basis.
j. One method of reducing the scope of the problem of assessing responsibility for damage to work in process is to make the "acceptance station" relatively short, on the order of, say, 100 or 200 feet, rather than 1/2 mile or 1 mile.
k. In the event of a hurricane, the construction contractor would suspend operations and attempt to move all personnel and equipment to the nearest safe harbor (probably Freeport). Cranes and other heavy equipment would be loaded onto barges and evacuated.

47. Issue: **Test Driving Piles Prior to Bidding**

The contractors felt that it would be helpful if the COE were to test drive some piles and allow interested bidders to observe if performance specs for this portion of the work were to be employed, but that this would not be needed if the COE is going to assume the risk by using procedural specifications.

48. Issue: **Subsurface Data For Bidding**

a. The contractors stated that they did not feel that doing bore holes every 300 feet in areas requiring piling would provide sufficient information upon which to base a bid.
b. The contractors requested cone penetration test results at each station requiring piling.

49. Issue: **Insurance Required**

a. The contractors identified the following types of insurance as likely to be used on this project:

- Workers Compensation
- Equipment
- Marine Insurance, on leased and owned equipment
- General Liability

b. Some contractors felt that builder's risk insurance could be obtained for this project, but that it would be very costly. Builder's Risk insurance would be procured probably only if the COE mandated it.

50. Issue: **Subcontractors**

a. The contractors in attendance did not foresee a large number of subcontractors being employed on this project.
b. The possible subcontractors are:

- Landscaping
- Portable toilets

51. Issue: **Bid Period**

a. The consensus was that a 30 day bid period, commencing after issuance of plans and specs, was appropriate, with additional time given for addenda as required.
b. During this bid period, the following demonstrations should be given to those contractors who bought plans and specs:

- A demonstration of the seepage into several test excavations in order for the contractors to evaluate the scope of the dewatering problem, if any, they can expect to encounter, particularly in the sheet pile and rolled clay sections.
- Test driving of piles in those areas requiring piles, if performance specs for this portion of the work are used. This demonstration will enable contractors to evaluate the problems they can expect to encounter in driving piles in these areas, particularly to determine if predrilling will be required.

52. Issue: **Bid Basis**

a. The following were offered as the preferred bases for bids:

- Armor Stone: Each
- Blanket Stone: Ton, Barge Measure
- Core Stone: Ton, Barge Measure
- Geotextile: Square Yard

- Excavation: Cubic Yard of Excavation
- Piles: Per Pile
- Pile Cap: Per Linear Foot of Pile Cap

A couple of contractors, however, felt that piling should be priced per linear foot installed, and not on a per pile basis, due to problems they expect would be encountered.

b. The general consensus was that barge measure was a fairer method of measuring the amount of core and blanket stone in place, since this would account for poor foundation soil conditions which could require more stone due to settlement.

c. One contractor pointed out that if granite is allowed as an alternative to precast concrete blocks, it is typically measured by the ton.

d. One contractor stated that the COE might want to consider measuring the armor units by barge measure as well.

e. The price for excavation should include excavation, stockpiling, and backfilling.

f. Excavation for areas requiring compacted backfill should be priced separately from excavation for areas not requiring that the backfill be compacted to any particular standard.

g. The specifications must clearly state the amount of grading required after backfilling any excavations.

53. Issue: **Scheduling**

a. Some contractors said they employed CPM schedules on every project and would do so on this project whether it was required or not. Others said that they did not really see the need for CPM scheduling on this project since they regarded it as being very simple, and would do a CPM only if expressly required to do so.

b. Several of the contractors said they did not have a problem with the COE's requirement to do a schedule on a project like this, but that what they did object to was the months-long process of meetings, etc. typically required to get a schedule approved.

54. Issue: **Project Acceleration**

a. Two options were identified for accelerating the work on this project if, for some reason, the work had fallen behind schedule:

1st Choice - Work overtime or add additional shifts
2nd Choice - Open additional work faces by bringing in additional crews and equipment.

b. Adding additional shifts could be done almost instantaneously, but opening additional work faces would require a 2-3 week logistics buildup first.

c. Opening additional work faces would entail costs basically equivalent to a second mobilization.

55. Issue: **Mobilization**

a. The COE typically pays 60% of the mob/demob cost upon mobilization and 40% upon demobilization.
b. One contractor reported that he is currently working on a COE project that is being paid on an 80/20% basis.
c. The contractors felt that 75% In/25% Out would be appropriate on this project due to the large amount of materials and equipment that will have to be moved to the site in order to start the project.

56. Issue: **Incentives/Liquidated Damages**

a. Several contractors said that they felt that incentives were appropriate on projects where the owner would benefit from early completion of the project, and that such incentive clauses did spur them to finish the projects earlier in order to get those incentive payments.
b. There was no call for early completion incentives on this project since no one could identify how the owner would benefit from early project completion.
c. Several contractors remarked that it usually cost a contractor much more of his own money for overhead expenses if a project is late than he is assessed for liquidated damages. No one stated, however, that they felt that liquidated damages would be inappropriate on this project.

57. Issue: **Partnering**

a. The contractors who had partnering experience, with the COE or other owners, said it was definitely a worthwhile effort.
b. The participants were informed of the results of a recently completed thesis done by a UT graduate student that documented the positive benefits of partnering on COE projects.
c. No obstacles to a successful partnering effort on this project were identified.
d. Several contractors noted that the project designers on this project should be included in the partnering effort, and not just the project engineer and inspectors responsible for administering the construction contracts. Involvement of the designers in the partnering effort will go a long way to successfully resolving any questions or problems that may arise on the project.
e. Among the particular issues that the contractors felt partnering would help resolve, and thus help avoid disputes, were:

- verification of mob/demob expenses
- resolving weather-related damages and expenses
- differing site conditions
- sheet pile installation, etc.

f. The possible relocation of the design section from Galveston under the COE reorganization was mentioned as possibly complicating the involvement of the designers in the partnering effort. The consensus was that it was an important enough issue that this should not be permitted to be an obstacle to their involvement.

58. Issue: **Alternative Dispute Resolution**

a. Partnering should reduce the need for dispute resolution.
b. The claims potential for this project was rated as low - moderate, but would depend on such things as:

- the size of the acceptance area as it relates to a contractor's exposure for damage to completed but not yet accepted work
- the project specifications, particularly with regard to the quality standards developed for the project
- the inclusion of and design and specs for the concrete sheet piling

c. The claims potential for the project should be lower if the concerns brought out in this constructability review are addressed by the designers.
d. Mediation was offered as an appropriate means of dispute resolution. The advantages are that it is reasonably inexpensive and not too time consuming. Its use should be spelled out in the contract documents.
e. The COE cannot accept the use of binding arbitration, but all other means of ADR are at least options.
f. Dispute Review Boards can be a crutch for weak project management, either on the part of the owner or contractor.

59. Issue: **Computer Simulation**

a. The contractors are not familiar with the capabilities of the computer modeling system being employed by CII in the study, and so cannot say whether it would be helpful to them or not.
b. Several said they had open minds about its use and were at least willing to take a look at the results produced to evaluate its utility.
c. One contractor questioned if computer simulation constituted a bit of overkill, on what he saw as a relatively simple and straightforward project.

60. Issue: **Contract Administration**

a. The project is expected to be administered by the Galveston District's Construction Division.
b. The project engineer and inspectors would probably work out of a project office located on the island. Providing project office space will probably be included in the contractor's scope of work.

61. Issue: **Plus/Delta Analysis of the Meeting**

a. A plus/delta analysis of the meeting revealed the following positive elements and elements requiring improvement:

Positive:
- The fact that a constructability meeting like this was held to give the contractors input into the project.
- The contractor input should result in an improved design for the project.
- A good cross-section of the industry was represented at the meeting.
- Much input was gathered for inclusion in the CII report.
- Potential problem areas with the design were identified.

Needs Improvement:
- More lead time to prepare for the meeting
- More senior representatives from the COE should have attended, possibly including the District Engineer, to hear contractor concerns first hand.
- Design and construction administration representatives should have attended, both to hear contractor concerns first hand, and to facilitate a two-way dialogue with the contractors.

62. Issue: **Usefulness of Constructability Reviews**

a. All present felt that the day was well spent and that a better project for all concerned should result from the effort.
b. Constructability conferences such as this one would yield even greater benefits if applied to more complex projects.

63. Issue: **Follow-up Meeting**

a. Many of the contractors expressed interest in being able to provide additional input to the project, and to hear the outcome of the issues that were raised in the meeting.
b. An attempt will be made to have another meeting to afford the contractors an opportunity to review and comment on the recommendations contained in the CII report before it is submitted to the Galveston District O/A 1 Sep 93. The target date for such a review is Aug 93. As an alternative to another meeting, copies of the draft CII report would be circulated for review and comment.

64. Issue: **Availability for Follow-up Questioning**

The contractors indicated a willingness to answer additional questions if need be and were agreeable to being contacted by the CII researchers as required.

APPENDIX K:

SARGENT BEACH, TEXAS EROSION CONTROL PROJECT

CONSTRUCTABILITY STUDY TABLE OF CONTENTS

(CII 1993)

TABLE OF CONTENTS

APPENDIX L:

CONSTRUCTABILITY SYMPOSIUM FOLLOW-UP QUESTIONNAIRE

CONSTRUCTABILITY SYMPOSIUM QUESTIONNAIRE

Instructions: Please complete the questions to the best of your ability and return the form in the enclosed envelope. Please DO NOT put your name or firm's name on the questionnaire. Thank you.

1. What was the *primary* reason you attended the Sargent Beach constructability symposium?

___ To learn more about the project from a business development standpoint.

___ To attempt to influence the design of the project as a result of my experience in this type of work.

___ As a personal favor to Chuck McGinnis.

___ Because CII sponsored it.

___ Other (Please Describe) _____

2. How much would you estimate your attendance cost your firm, in terms of airfare, the cost of your time, etc.? $_____

3. What did you expect to get from the symposium? _____
_____
_____
_____
_____
_____
_____.

4. What did you actually get from it? _____
_____
_____
_____
_____
_____
_____.

5. Of the 12 factors listed below, rank order the 7 factors most critical to making a constructability symposium a success. (1 = most important, 2 = 2nd most important, and so on.)

___ Facilitator knowledgeable in the type of construction being discussed

___ Neutral site for the meeting

___ Owner or A/E reps in attendance who have decision-making authority

___ Quality read-ahead packet sent to all attendees prior to the meeting

___ Proper meeting facility atmosphere (audio-visual support, refreshments, seating arrangements, etc.)

___ Selection of qualified contractors to attend

___ Project overview briefing given at start of symposium

___ Neutral agency putting on the symposium (as opposed to, say, the owner running it himself)

___ Well-developed meeting agenda

___ Large number of different contracting firms represented

___ Owner takes action based on the issues raised in the symposium

___ Other (Please describe) _____

6. Would you attend a similar symposium for a different project? ___ Yes ___ No
If not, why not? _____
_____

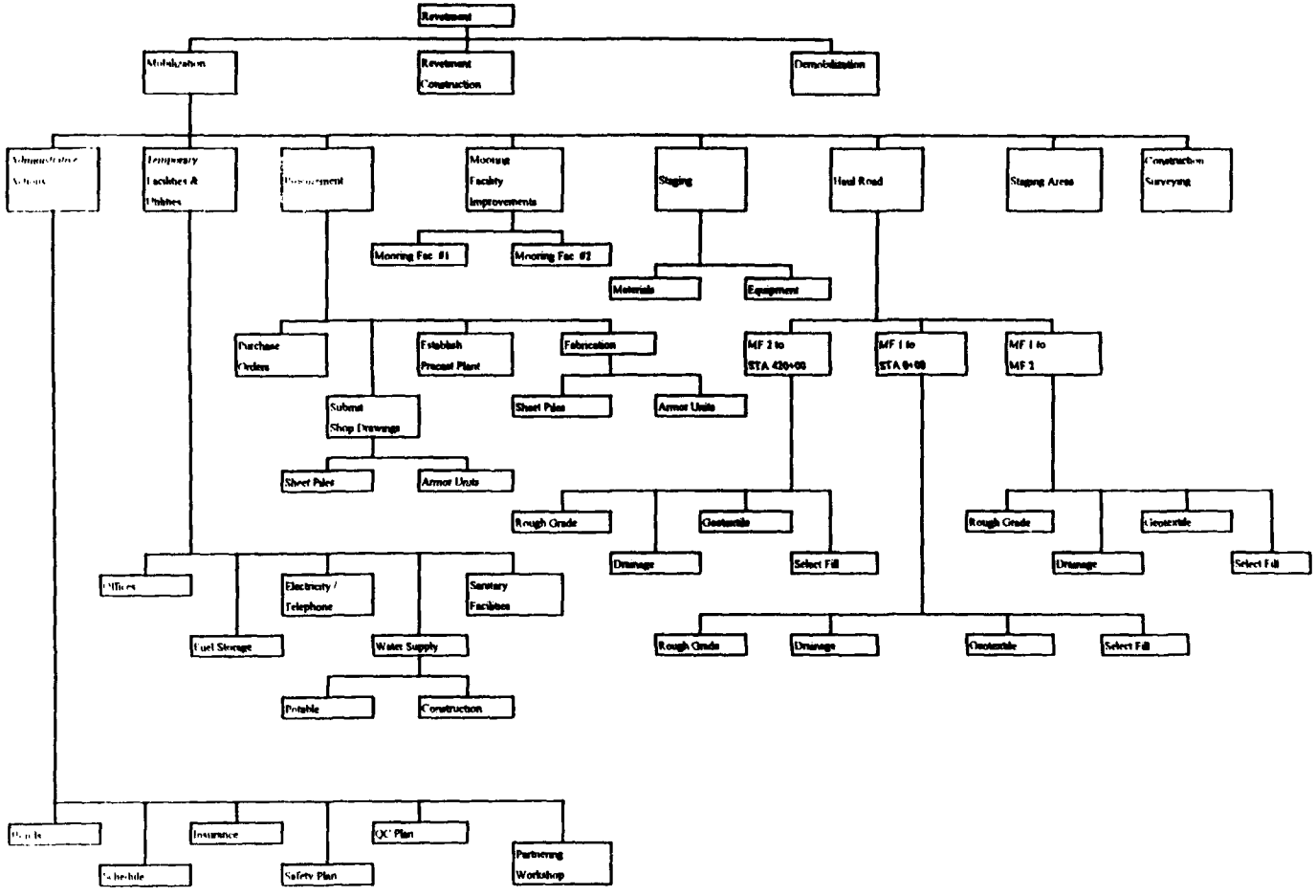
7. Additional Comments: _____
_____
_____
_____
_____.

Thank you.

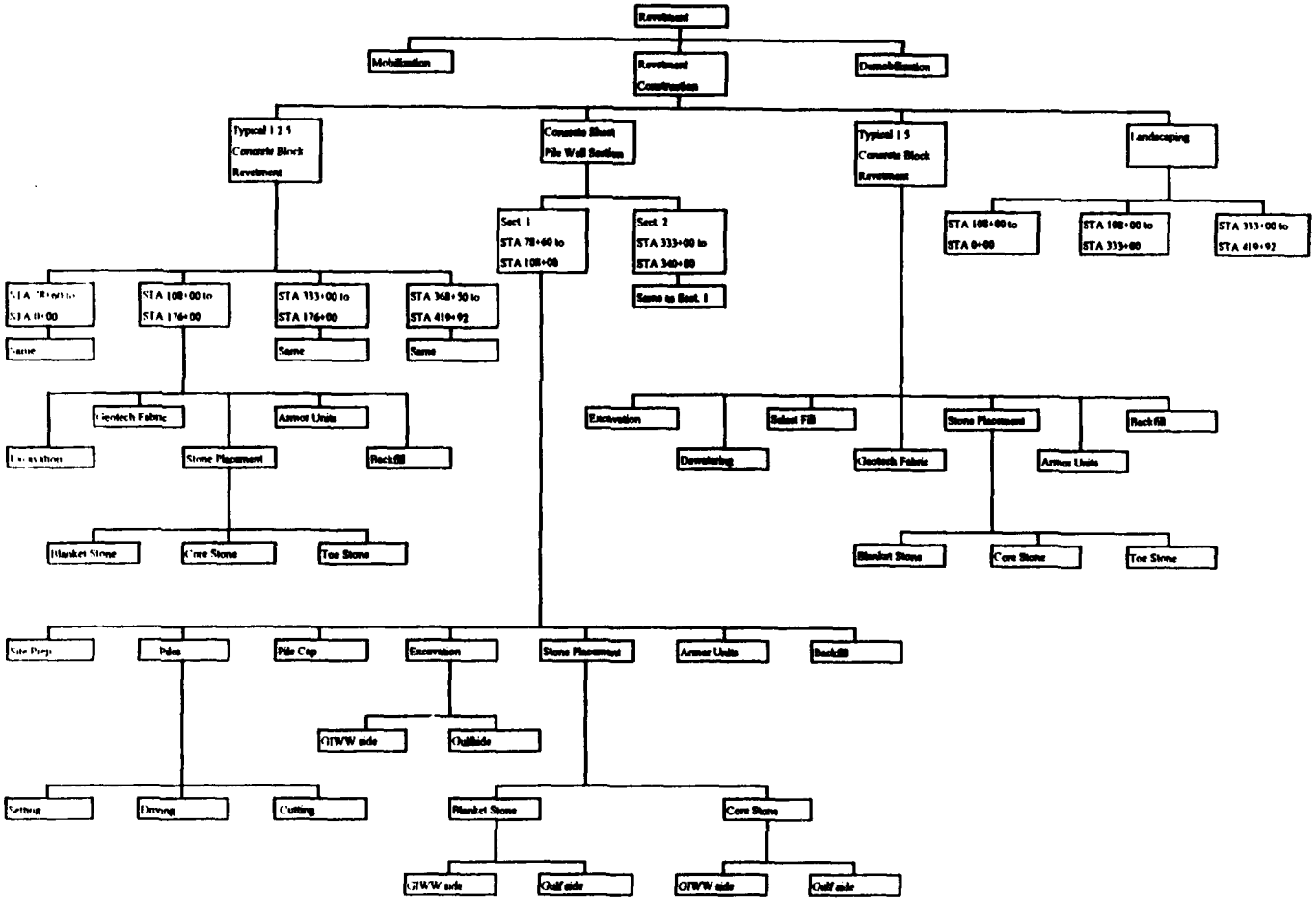
APPENDIX M:

PROJECT WORK BREAKDOWN STRUCTURE

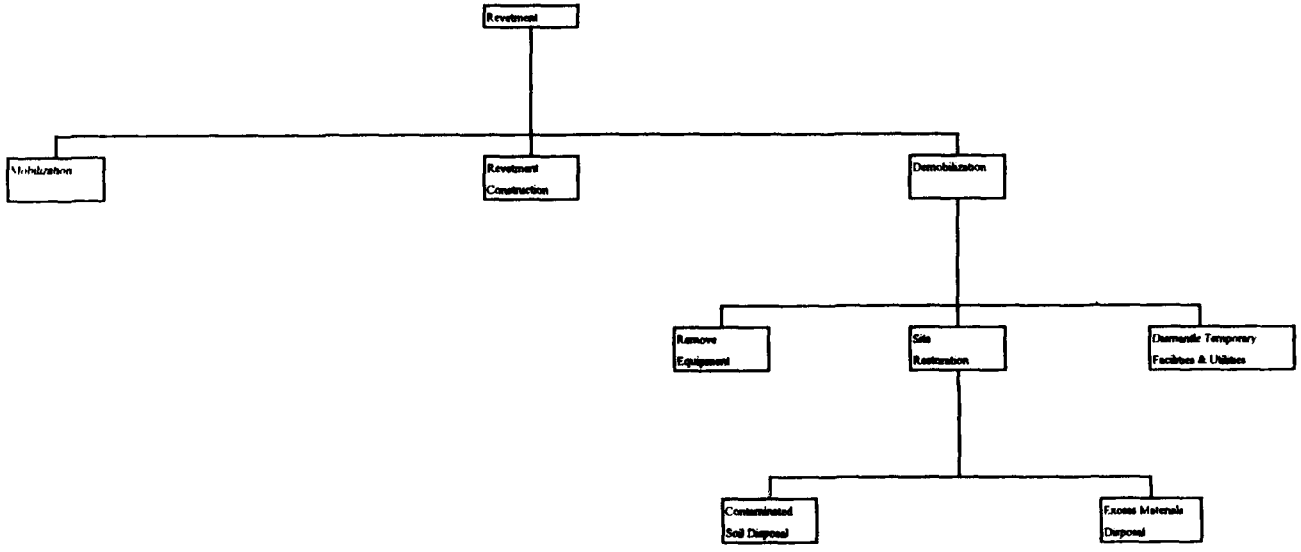
Work Breakdown Structure - Mobilization



Work Breakdown Stucture - Revetment Construction

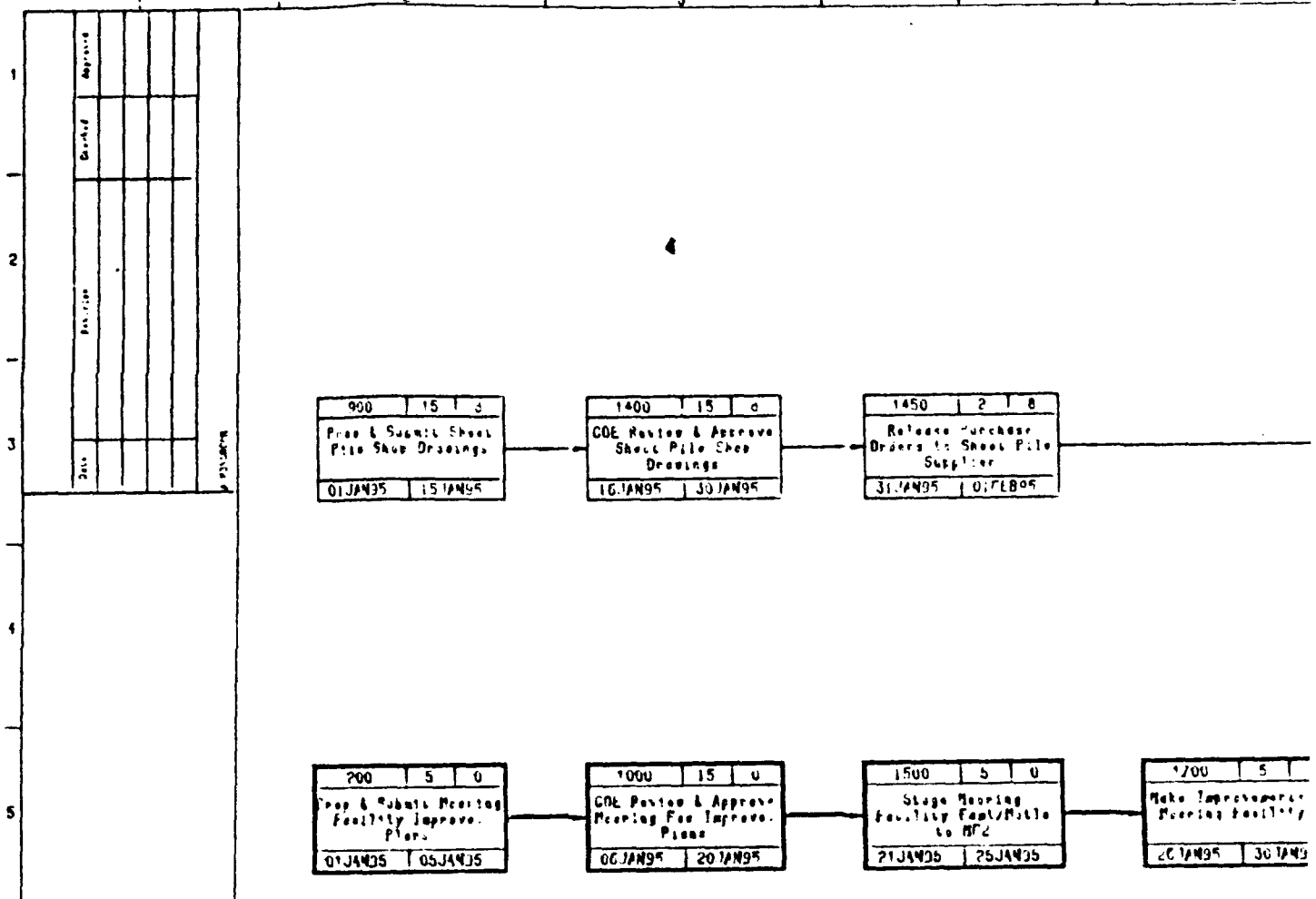


Work Breakdown Structure - Demobilization

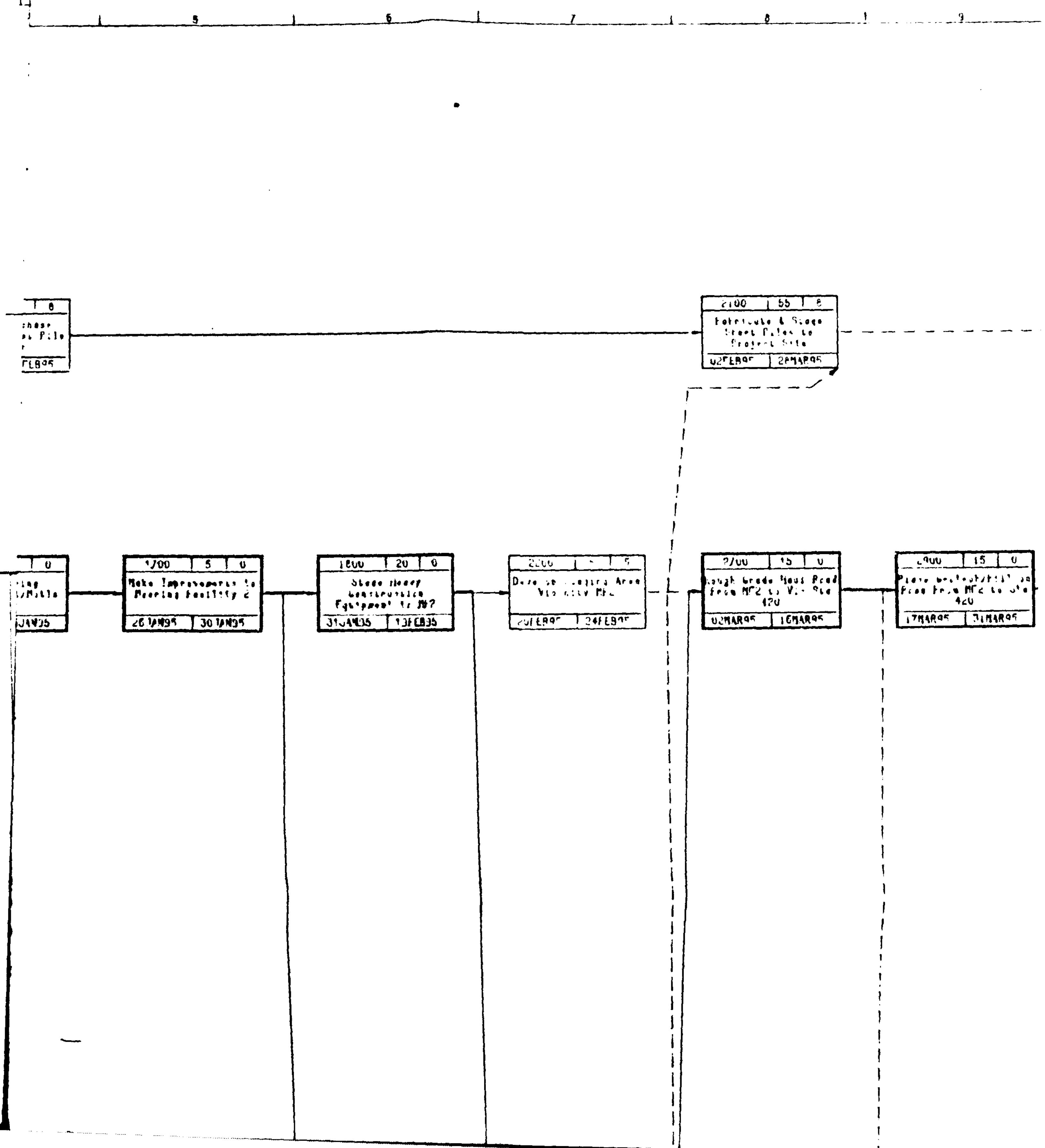


APPENDIX N:

CPM NETWORK DIAGRAM



Structability Study
ent Beach Revetment
Logic Diagram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6
7
8
9
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1800 | 20 | 0
Stage Heavy Construction Equipment to MF2
31JAN95 | 13FEB95
2200
20FEB95 | 24FEB95
2700 | 15 | 0
From MF2 to Vic Site 420
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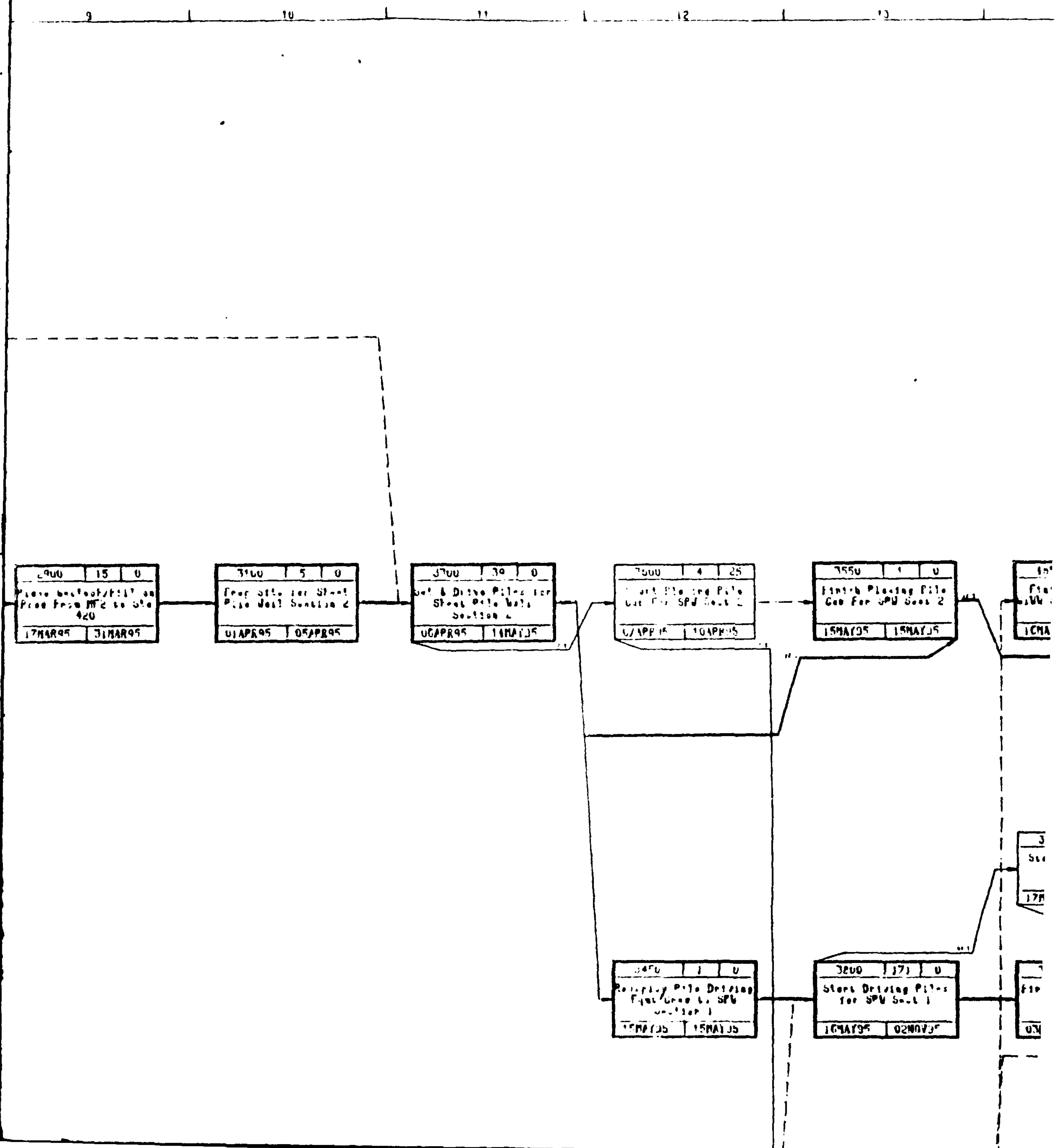
2900 | 15 | 0
420
17MAR95 | 31MAR95

3



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10
11
12
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17MAR95 31MAR95
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3700 39 0
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06APR95
7500 4 25
Cap For SPW Sect 2
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15MAY95 15MAY95
3800 171 0
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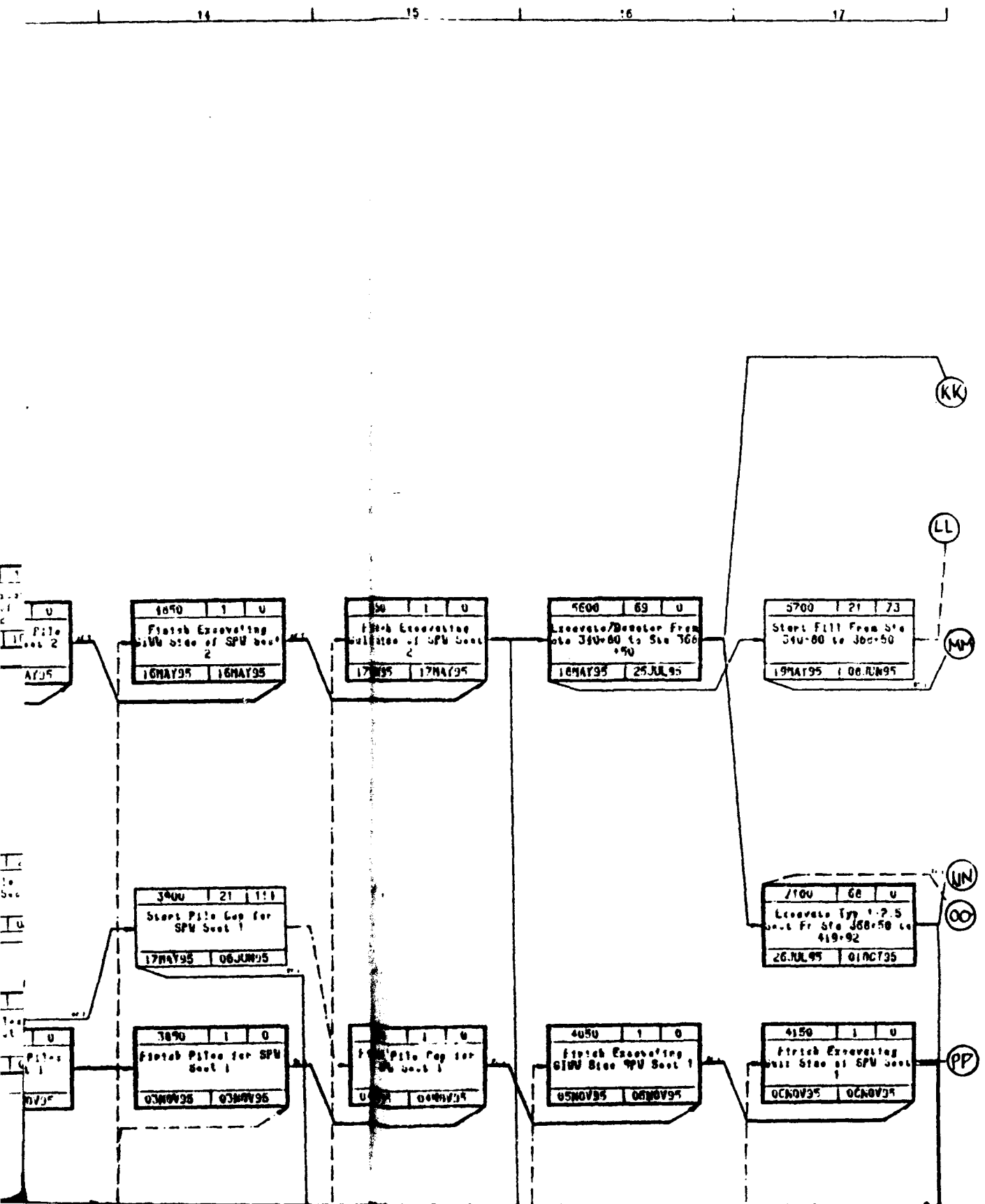
16MAY95 02NOV95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LL
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5600 | 69 | 0
Excavate/Dewater From Sta 360+80 to Sta 366 +90
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5700 | 21 | 73
Start Fill From Sta 360+80 to 366+50
19MAY95 | 06JUN95
3400 | 21 | 111
Start Pile Cap for SPW Seet 1
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Excavate Typ 1:2.5 Seet Fr Sta 368+50 to 419+92
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Finish Piles for SPW Seet 1
03NOV95 | 03NOV95
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Finish Excavating GIWW Btee SPW Seet 1
05NOV95 | 06NOV95
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Finish Excavating GIWW Btee at SPW Seet 1
07NOV95 | 07NOV95

Plot Date: 13AUG93
Data Date: 01JAN95
Project Start : 01JAN95
Project Finish: 08JUN96

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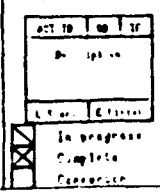
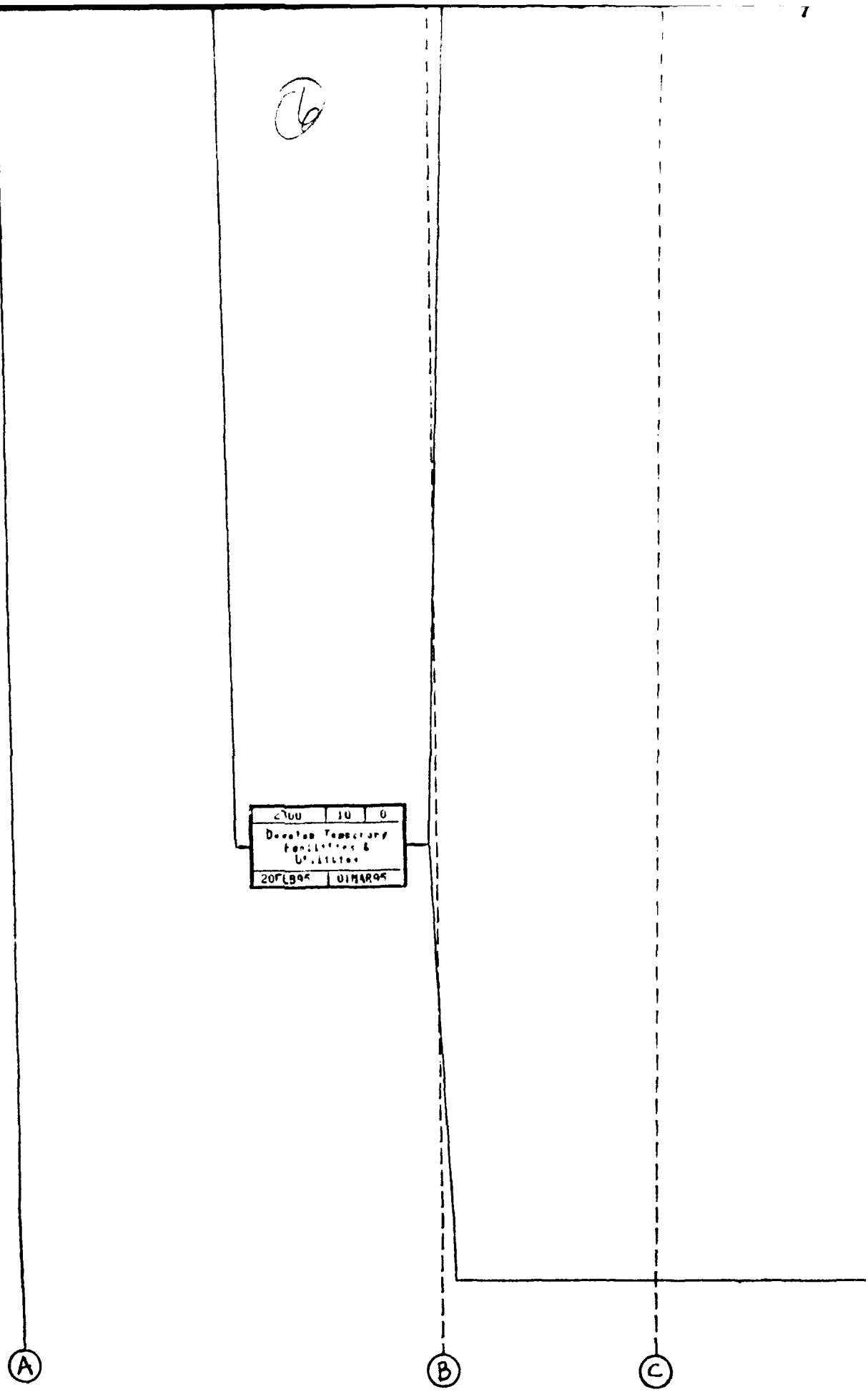
LEGEND



SANG

Constructability Study
Sargent Beach Revetment
Logic Diagram

5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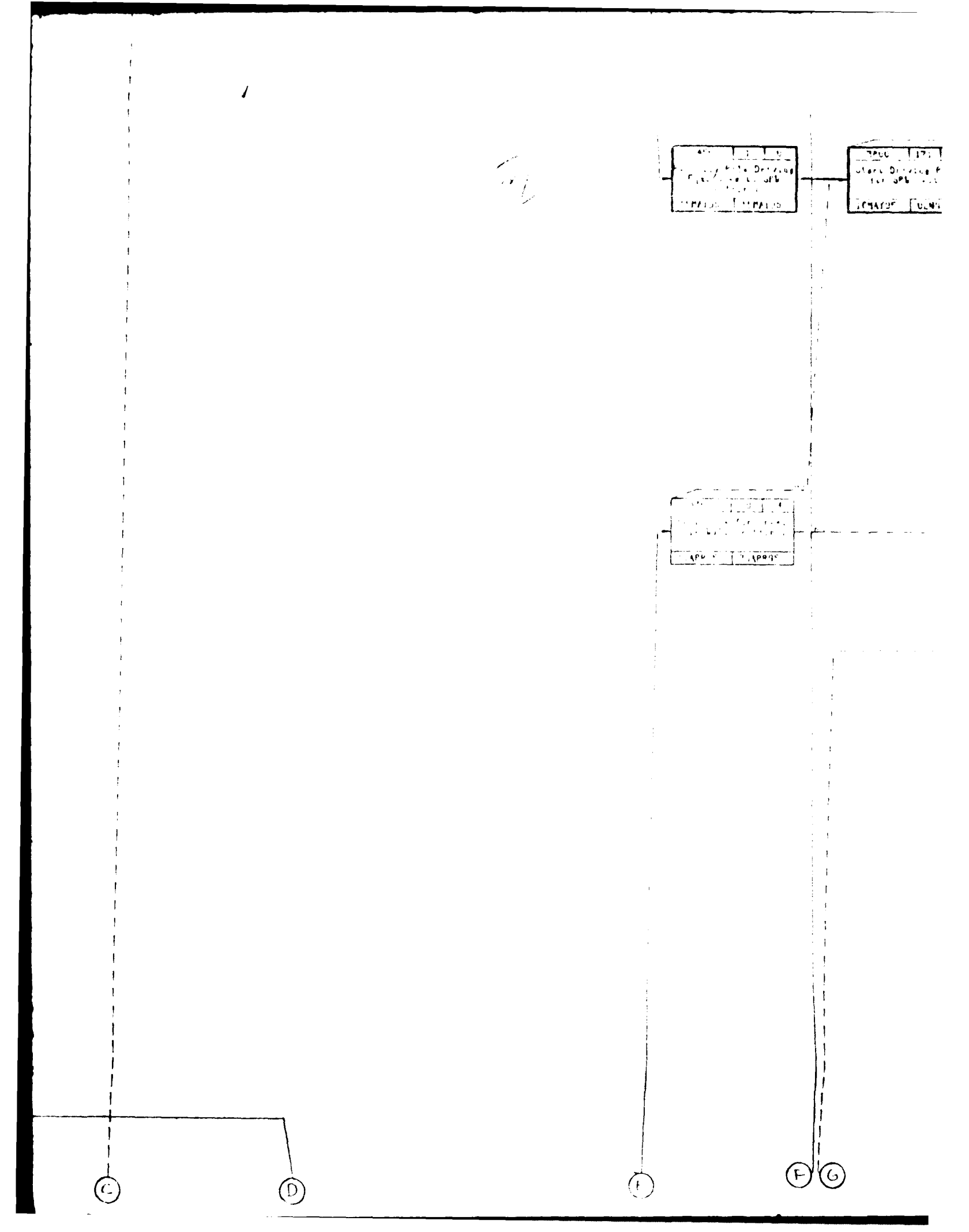
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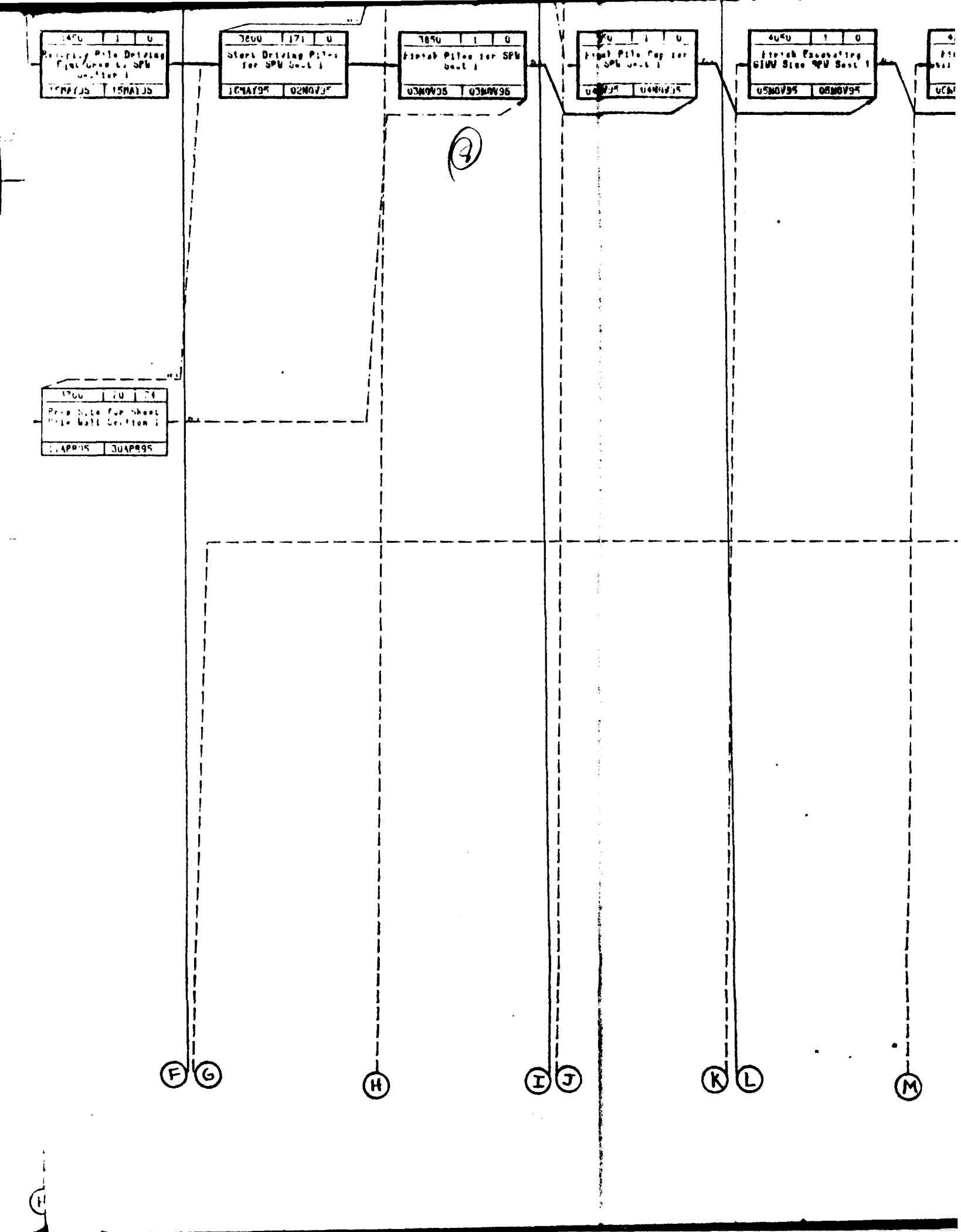
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Pile Driving
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3600 | 171 | 0
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Finish Piles for SPW Seat 1
03NOV95 | 03NOV95
4050 | 1 | 0
Finish Excavating GIW Sta. SPW Seat 1
05NOV95 | 05NOV95
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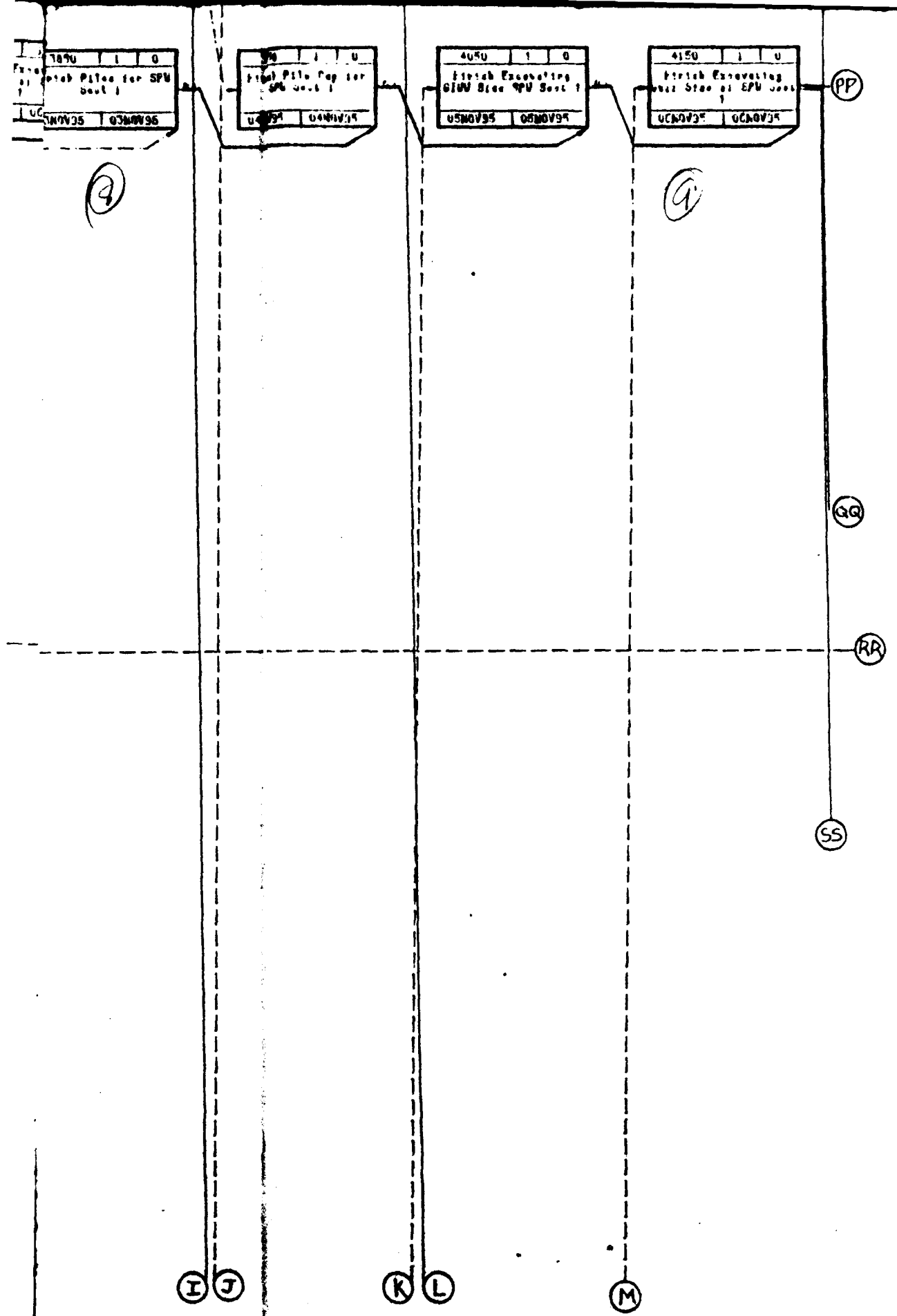
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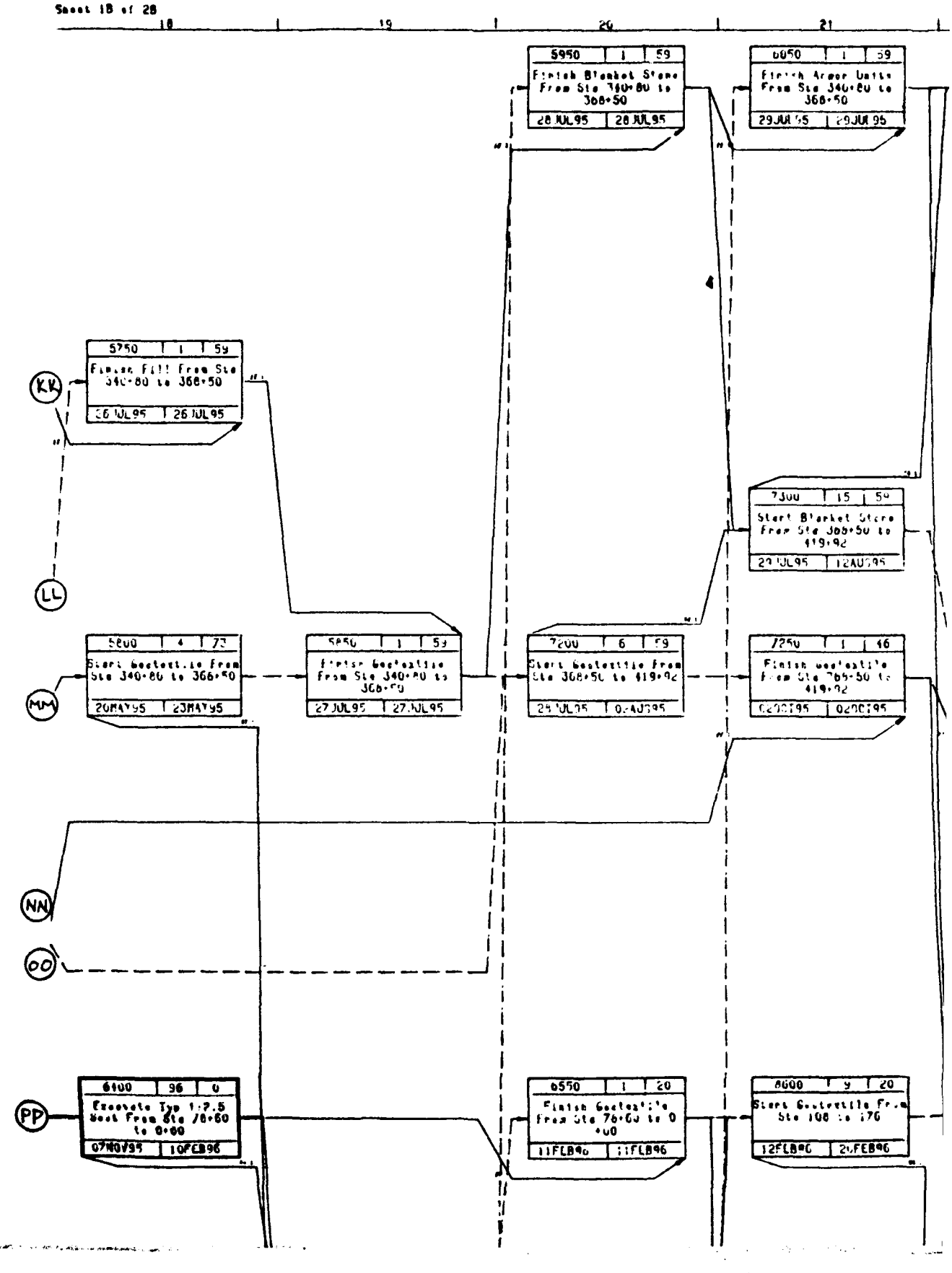
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19
20
21
5950 | 1 | 59
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6050 | 1 | 59
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29JUL95 | 29JUL95
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Finish Fill From Sta 340+80 to 368+50
26JUL95 | 26JUL95
KK
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7300 | 15 | 59
Start Blanket Stone From Sta 368+50 to 419+92
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NN
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07NOV95 | 10FEB96
PP
6550 | 1 | 20
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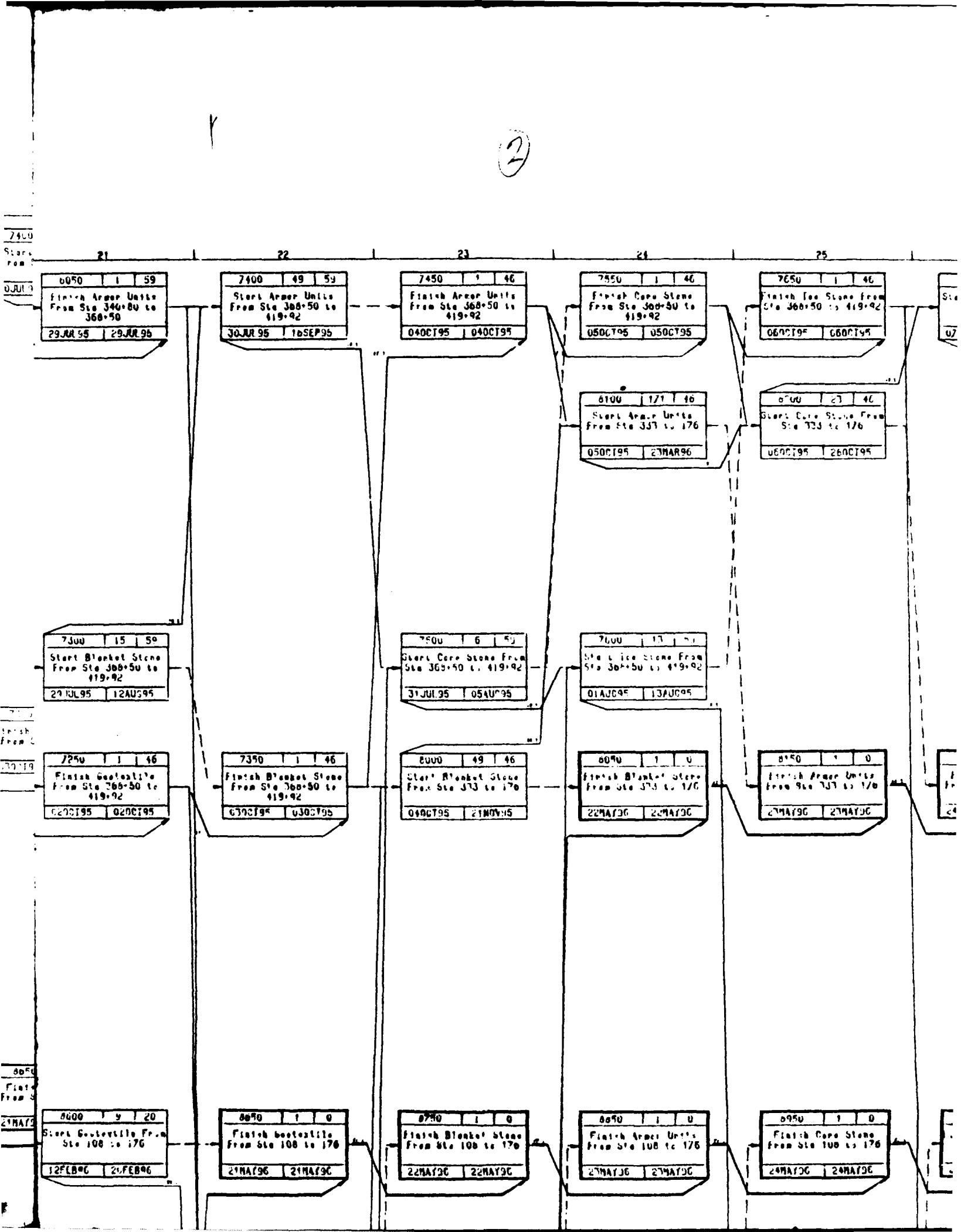
8000 | 9 | 20
Start Geotextile From Sta 108 to 170
12FEB96 | 20FEB96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04OCT95 | 04OCT95
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Finish Core Stone From Sta 368+50 to 419+92
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Finish Toe Stone From Sta 368+50 to 419+92
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6200 | 23 | 46
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7000 | 13 | 59
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8000 | 9 | 20
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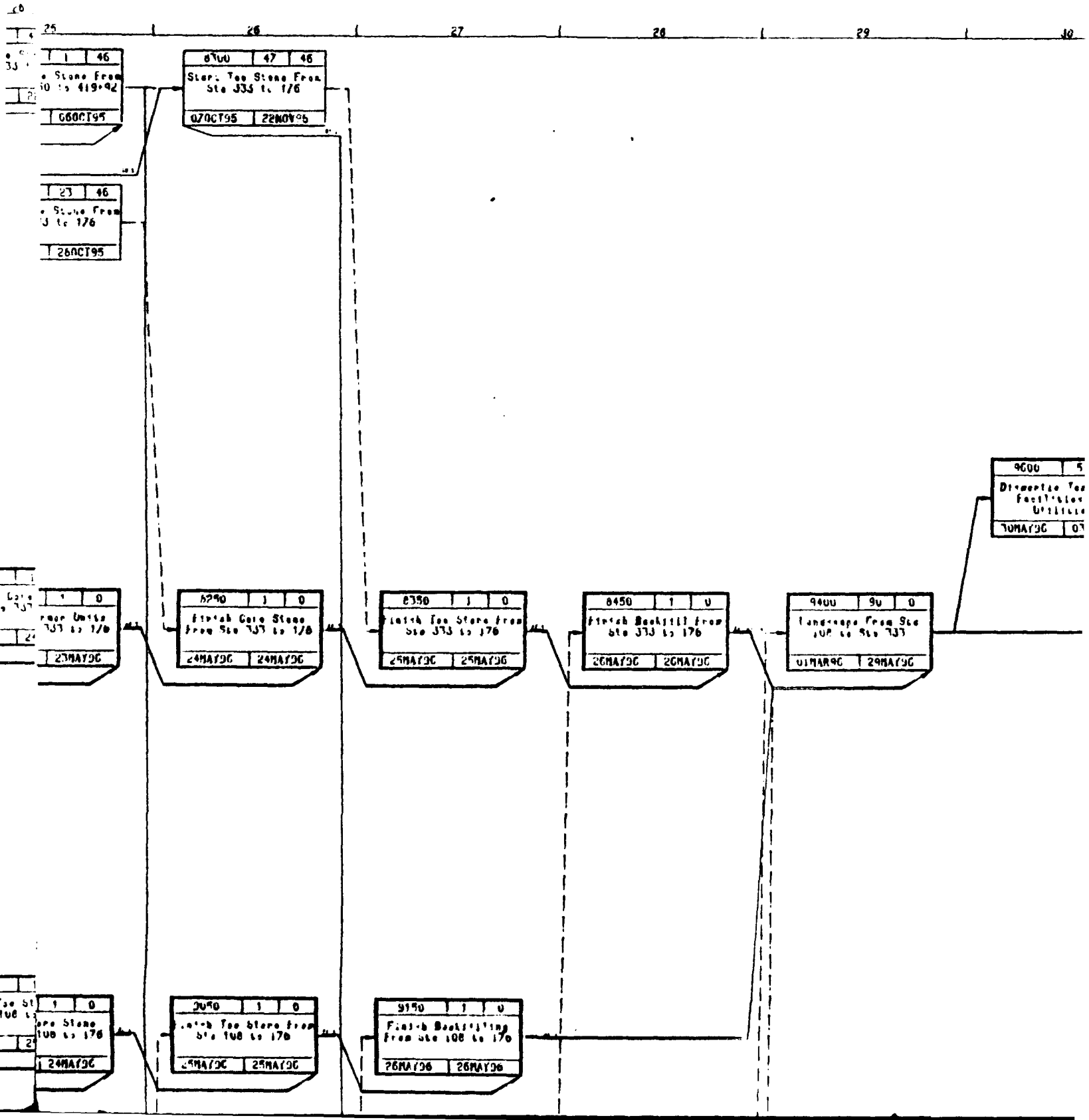
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8350 1 0
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25MAY96 25MAY96
8450 1 0
Finish Backfill From Sta 373 to 176
26MAY96 26MAY96
9400 90 0
Landscape From Sta 108 to Sta 737
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9600
Driveway Tee Facilities Utilities
30MAY96
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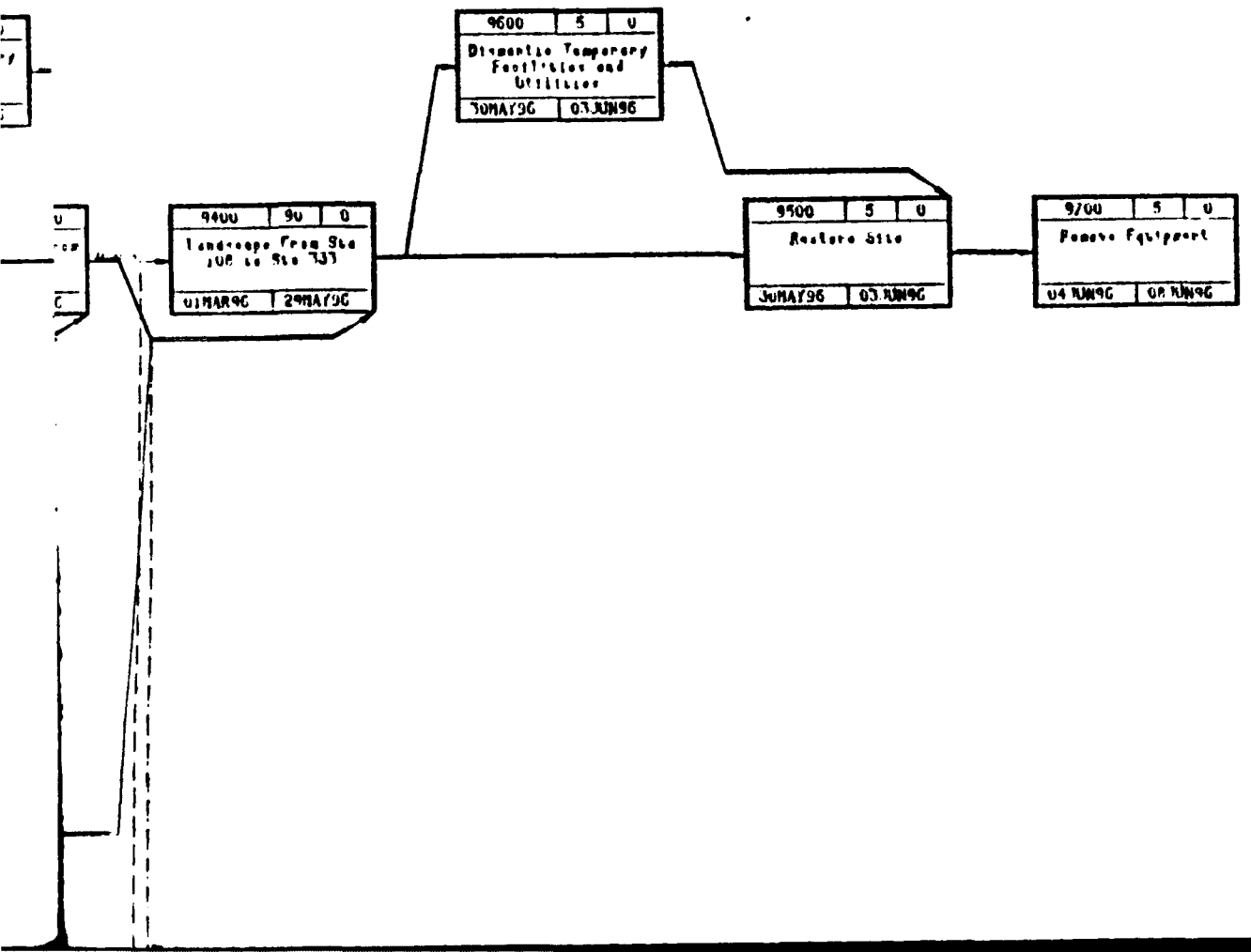
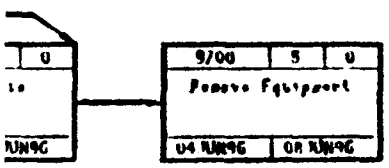
Finish Backfilling From Sta 108 to 176
26MAY96 26MAY96

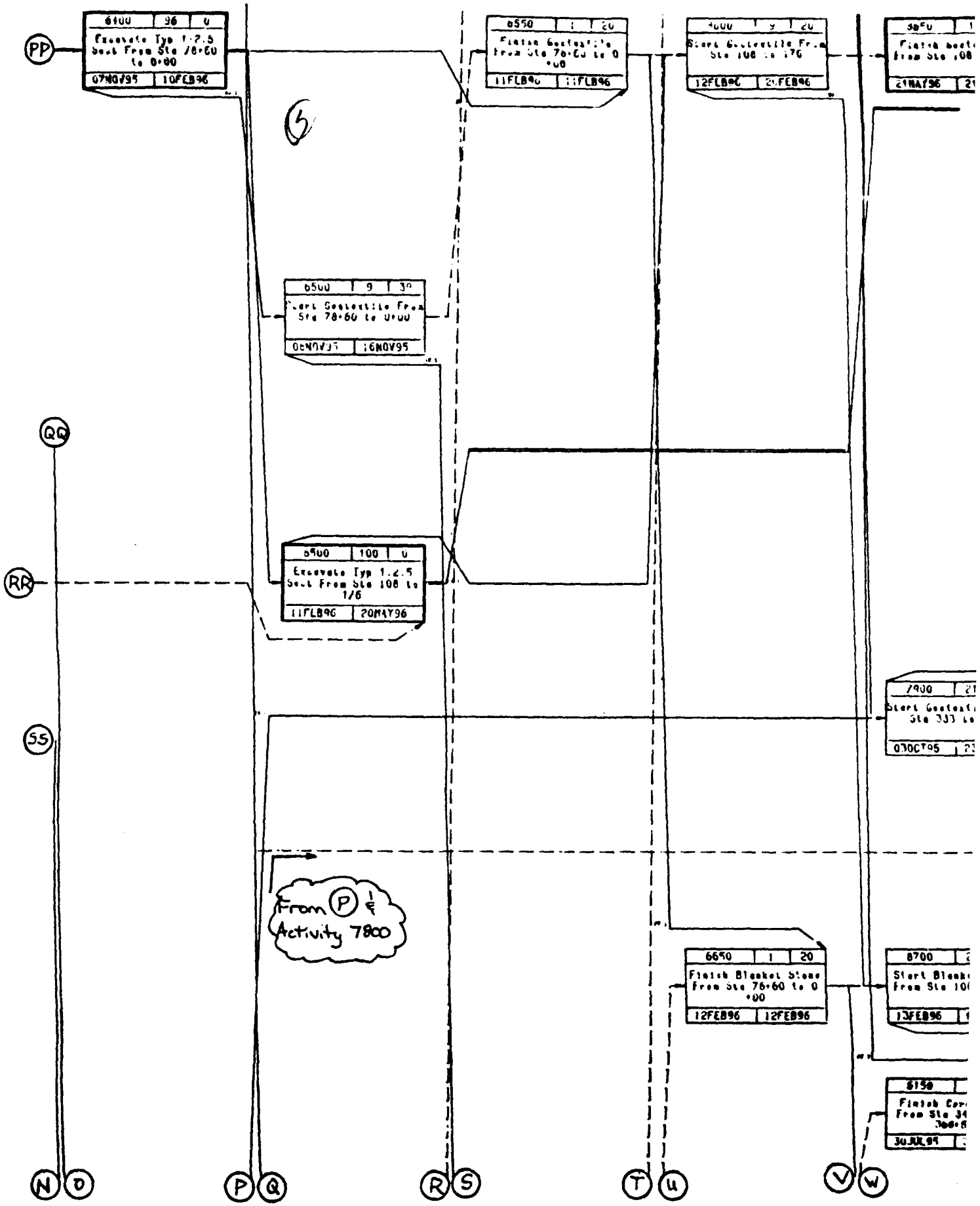

9600
5
0
Dismantle Temporary Facilities and Utilities
30MAY96
03JUN96
9400
90
0
Landscape Prep Ste Job to Ste 737
01MAR96
29MAY96
9500
5
0
Restore Site
30MAY96
03JUN96
9700
5
0
Remove Equipment
04JUN96
08JUN96

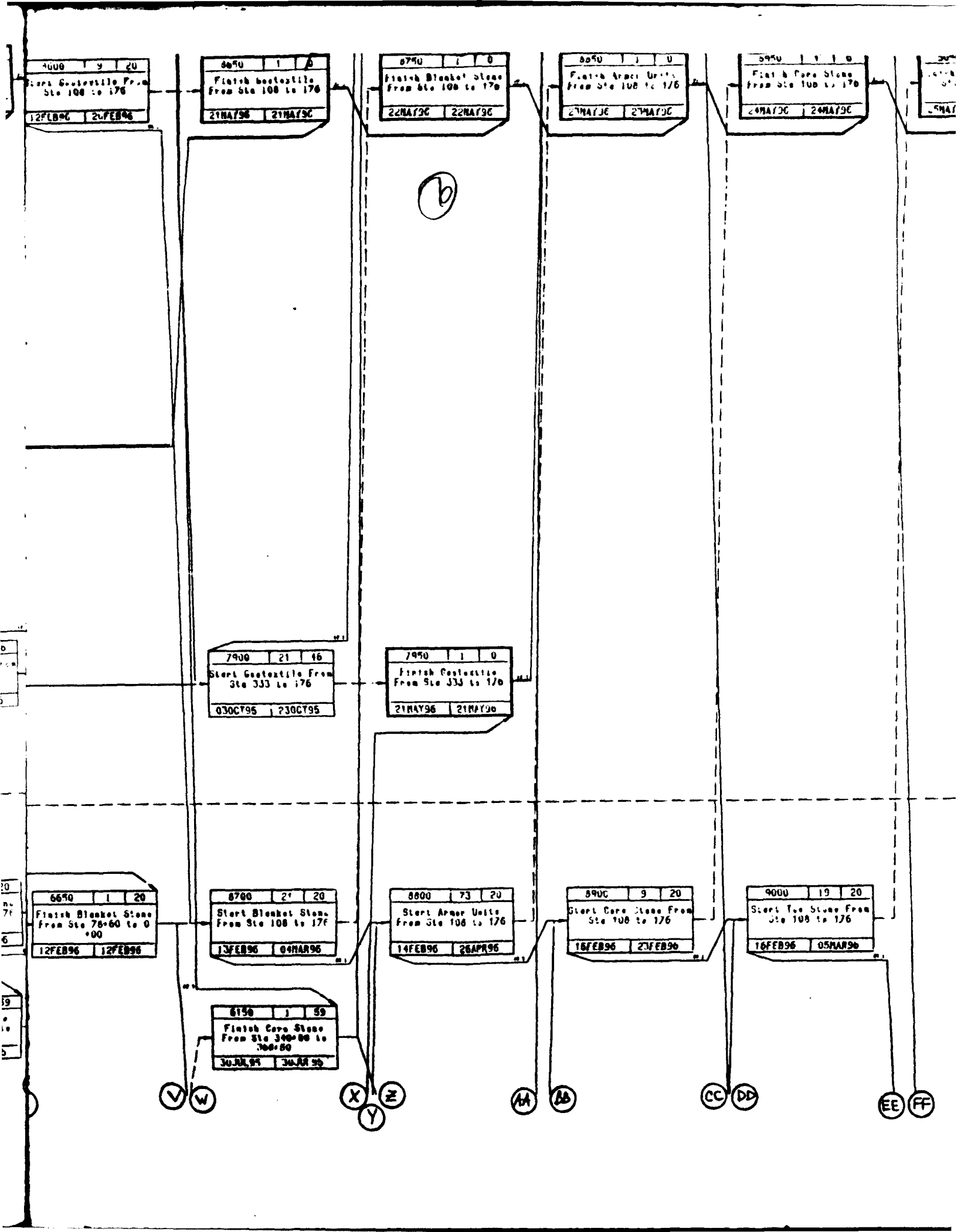
(4)

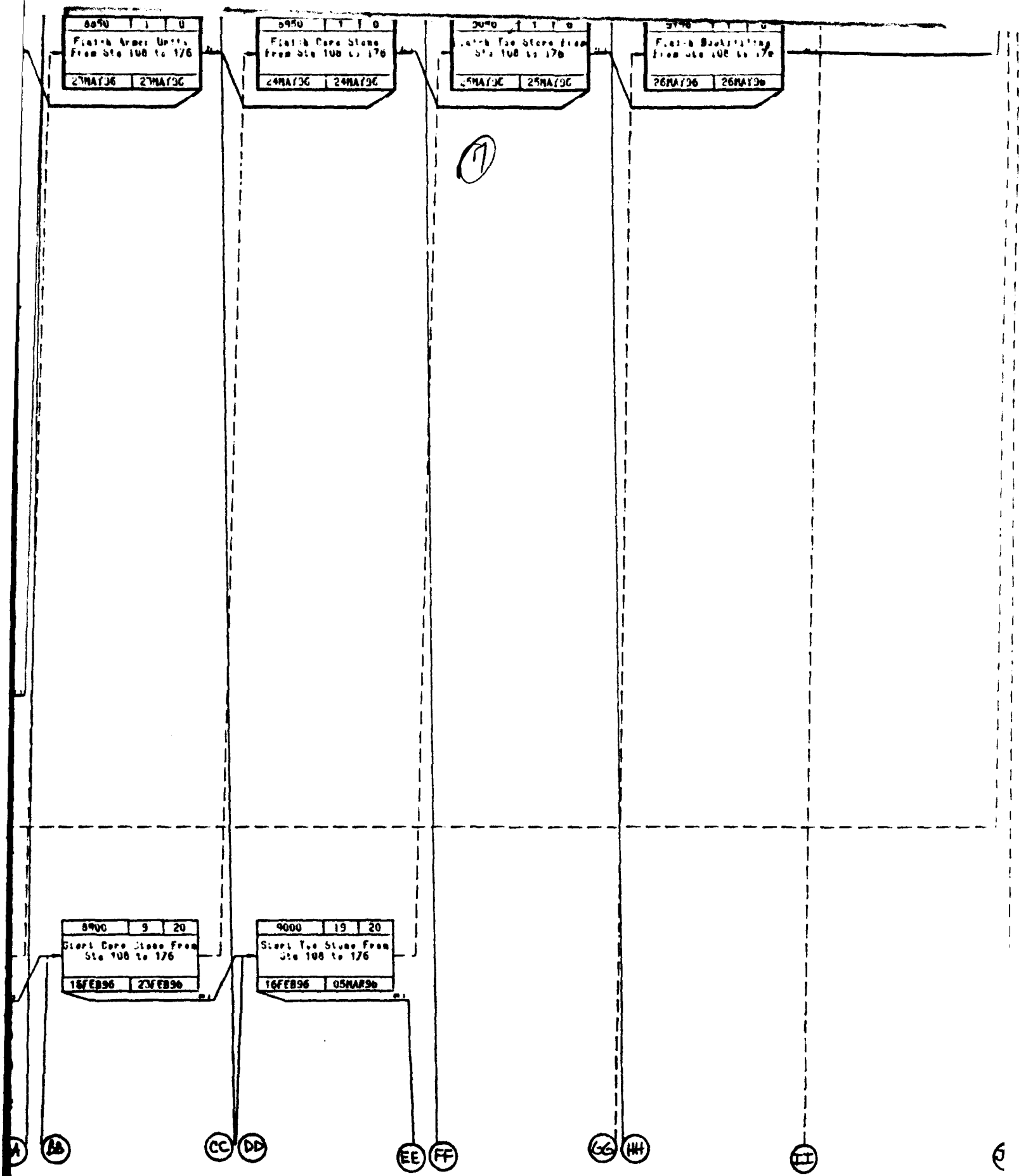
32 33 34

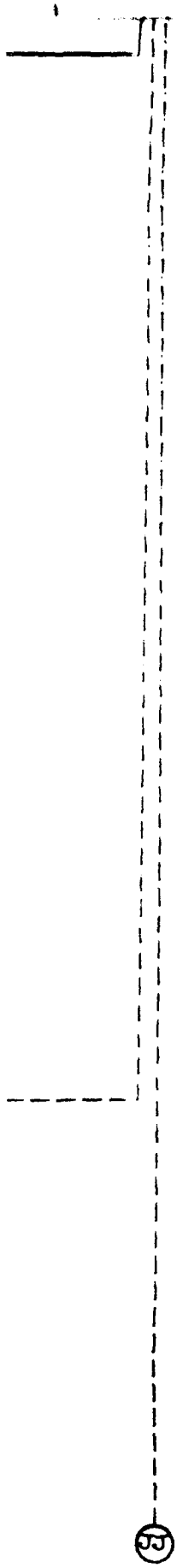
1 2 3 4 5 6 7 8




6400 | 96 | 0
Excavate Typ 1:2.5 Sect From Sta 78+60 to 0+00
07NOV95 | 10FEB96
6550 | 1 | 20
Finish Geotextile From Sta 78+60 to 0 +00
11FLB96 | 11FLB96
6500 | 9 | 30
Start Geotextile From Sta 78+60 to 0+00
08NOV95 | 16NOV95
6500 | 100 | 0
Excavate Typ 1:2.5 Sect From Sta 108 to 1/6
11FLB96 | 20MAY96
6650 | 1 | 20
Finish Blanket Stone From Sta 78+60 to 0 +00
12FEB96 | 12FEB96
From (P) & Activity 7800
PP
QQ
RR
SS
N
O
P
Q
R
S
T
U
V
W


8650 | 1 | 0
Finish Geotextile From Sta 108 to 176
21MAY96 | 21MAY96
6750 | 1 | 0
Finish Blanket Stone From Sta 108 to 176
22MAY96 | 22MAY96
8650 | 1 | 0
Finish Armor Units From Sta 108 to 176
24MAY96 | 24MAY96
8950 | 1 | 0
Finish Core Stone From Sta 108 to 176
24MAY96 | 24MAY96
7900 | 21 | 16
Start Geotextile From Sta 333 to 176
030CT95 | 230CT95
7950 | 1 | 0
Finish Geotextile From Sta 333 to 176
21MAY96 | 21MAY96
6650 | 1 | 20
Finish Blanket Stone From Sta 78+60 to 0+00
12FEB96 | 12FEB96
6700 | 21 | 20
Start Blanket Stone From Sta 108 to 176
13FEB96 | 04MAR96
8800 | 73 | 20
Start Armor Units From Sta 108 to 176
14FEB96 | 26APR96
8900 | 9 | 20
Start Core Stone From Sta 108 to 176
16FEB96 | 23FEB96
9000 | 19 | 20
Start Toe Stone From Sta 108 to 176
16FEB96 | 05MAR96
6750 | 1 | 59
Finish Core Stone From Sta 340+80 to 300+80
30JUL95 | 30JUL95
b
V
W
X
Y
Z
AA
BB
CC
DD
EE
FF


8990 | 1 | 0
Fetch Armor Units From Ste 108 to 176
27MAY96 | 27MAY96
8990 | 1 | 0
Fetch Core Stone From Ste 108 to 176
24MAY96 | 24MAY96
8990 | 1 | 0
Fetch Tee Stone from Ste 108 to 176
25MAY96 | 25MAY96
8990 | 1 | 0
Fetch Substitute From Ste 108 to 176
26MAY96 | 26MAY96
7
8900 | 9 | 20
Start Core Stone From Ste 108 to 176
16FEB96 | 23FEB96
9000 | 19 | 20
Start Tee Stone From Ste 108 to 176
16FEB96 | 05MAR96
AA
BB
CC
DD
EE
FF
GG
HH
II



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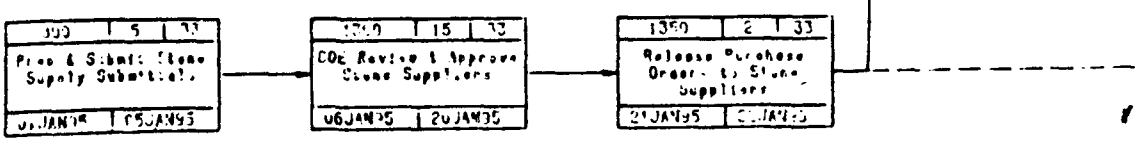
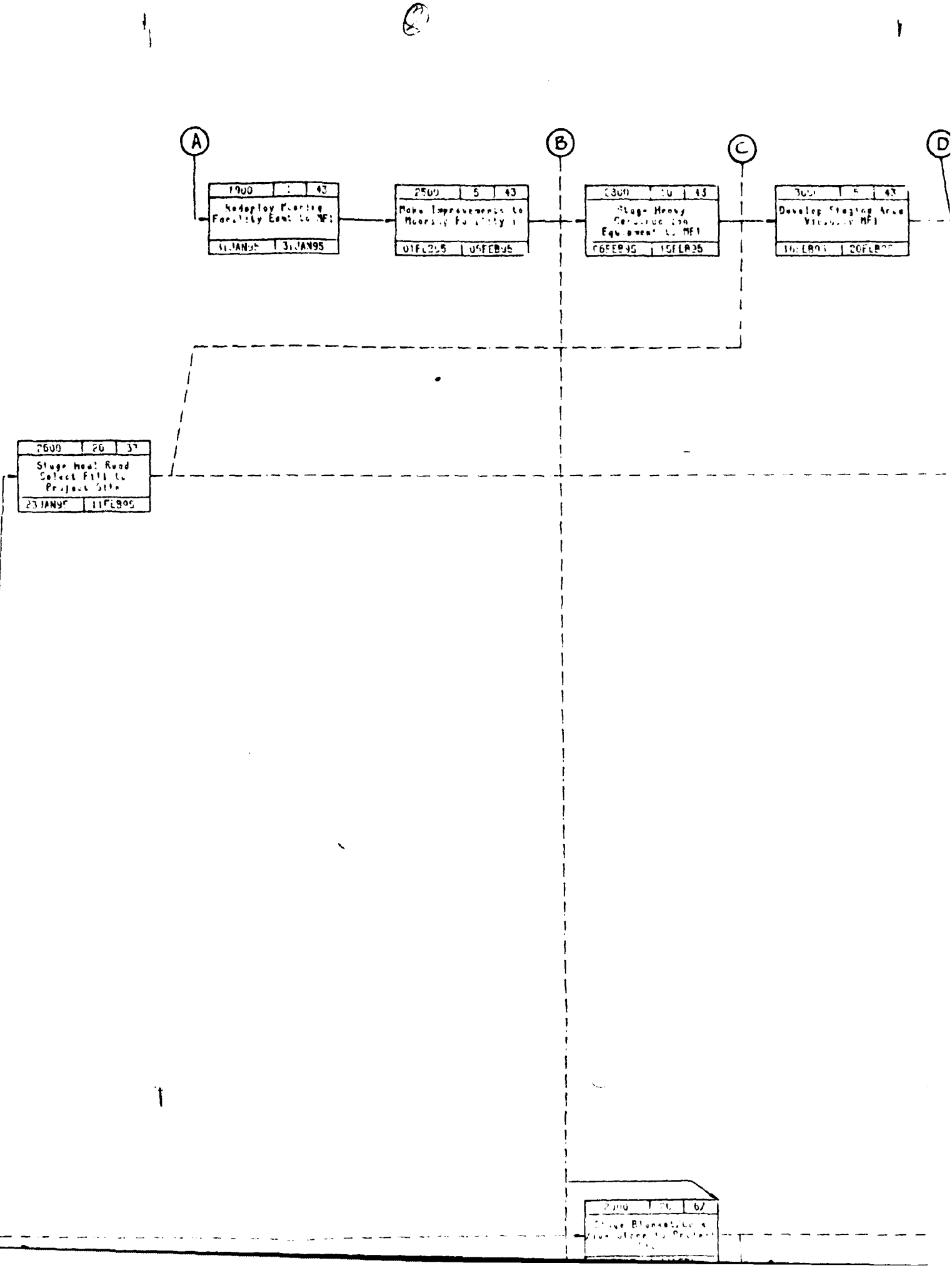
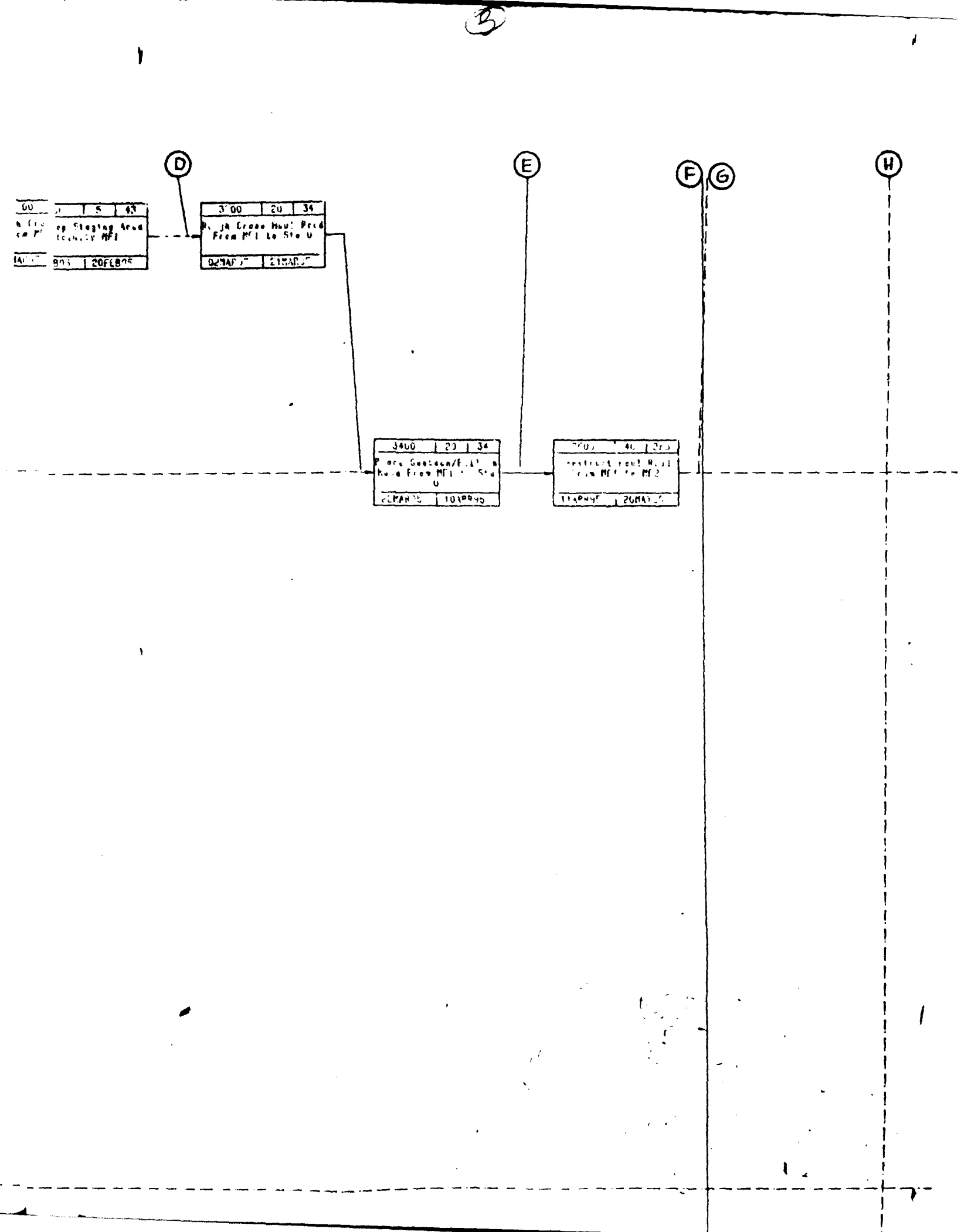
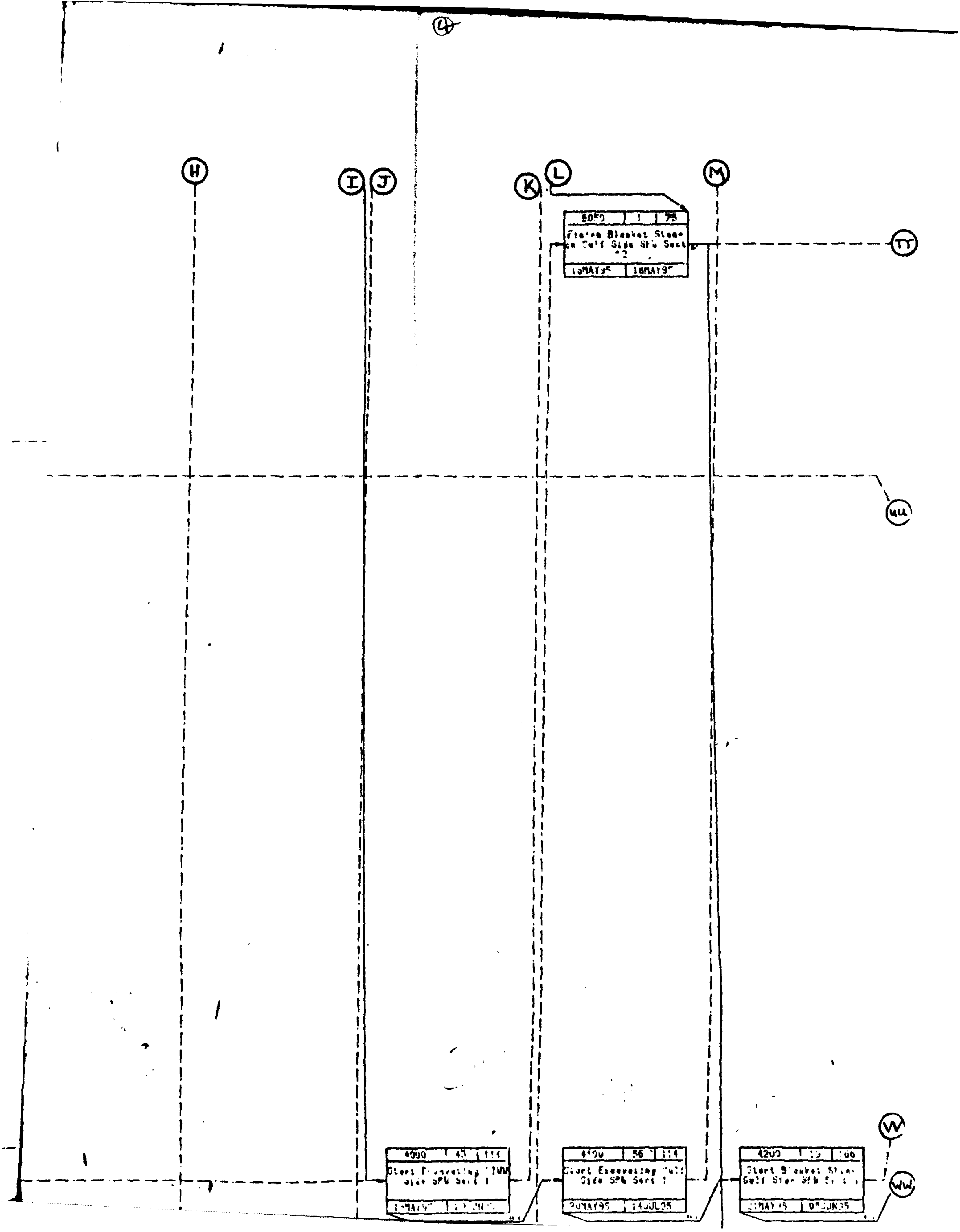
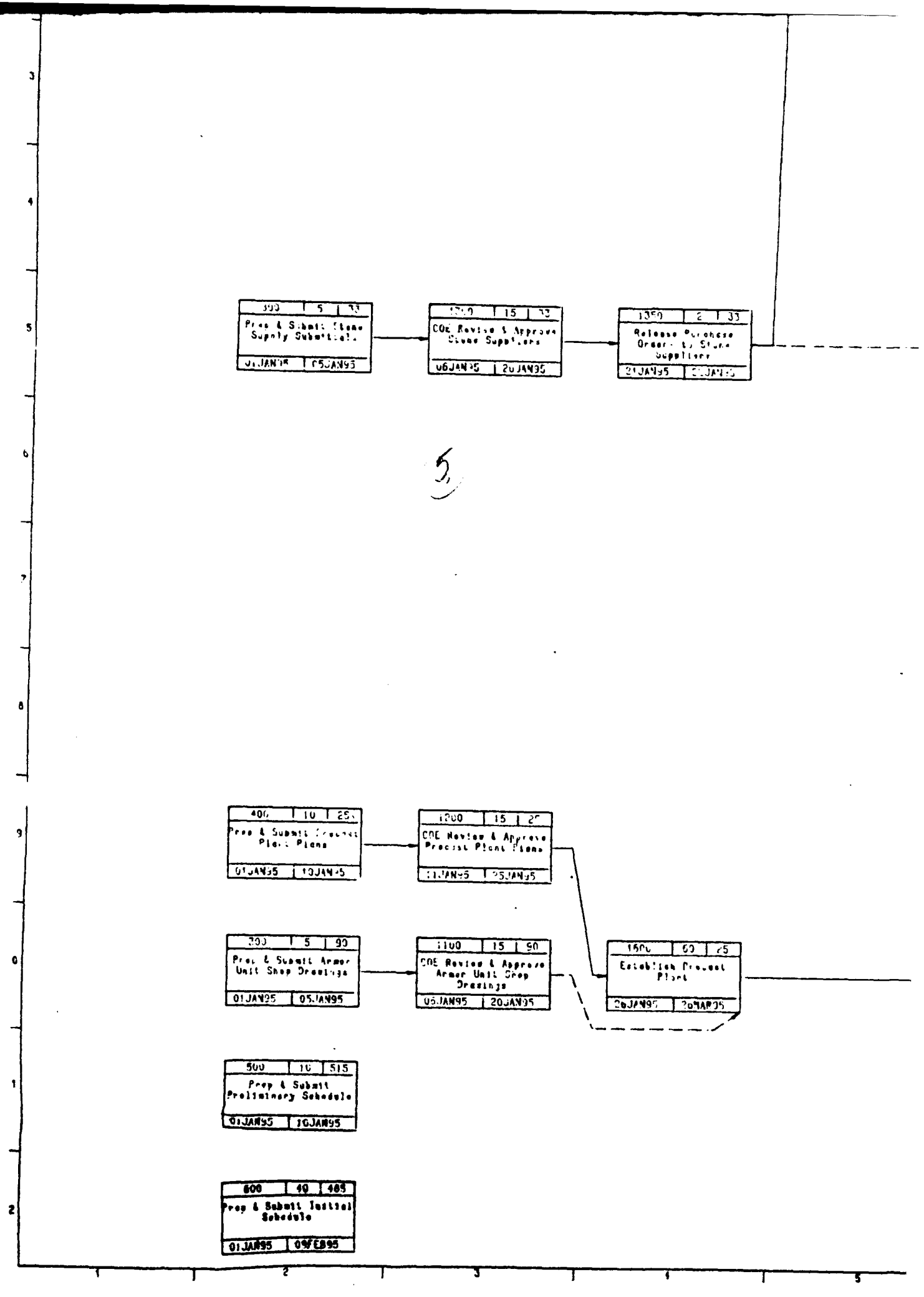
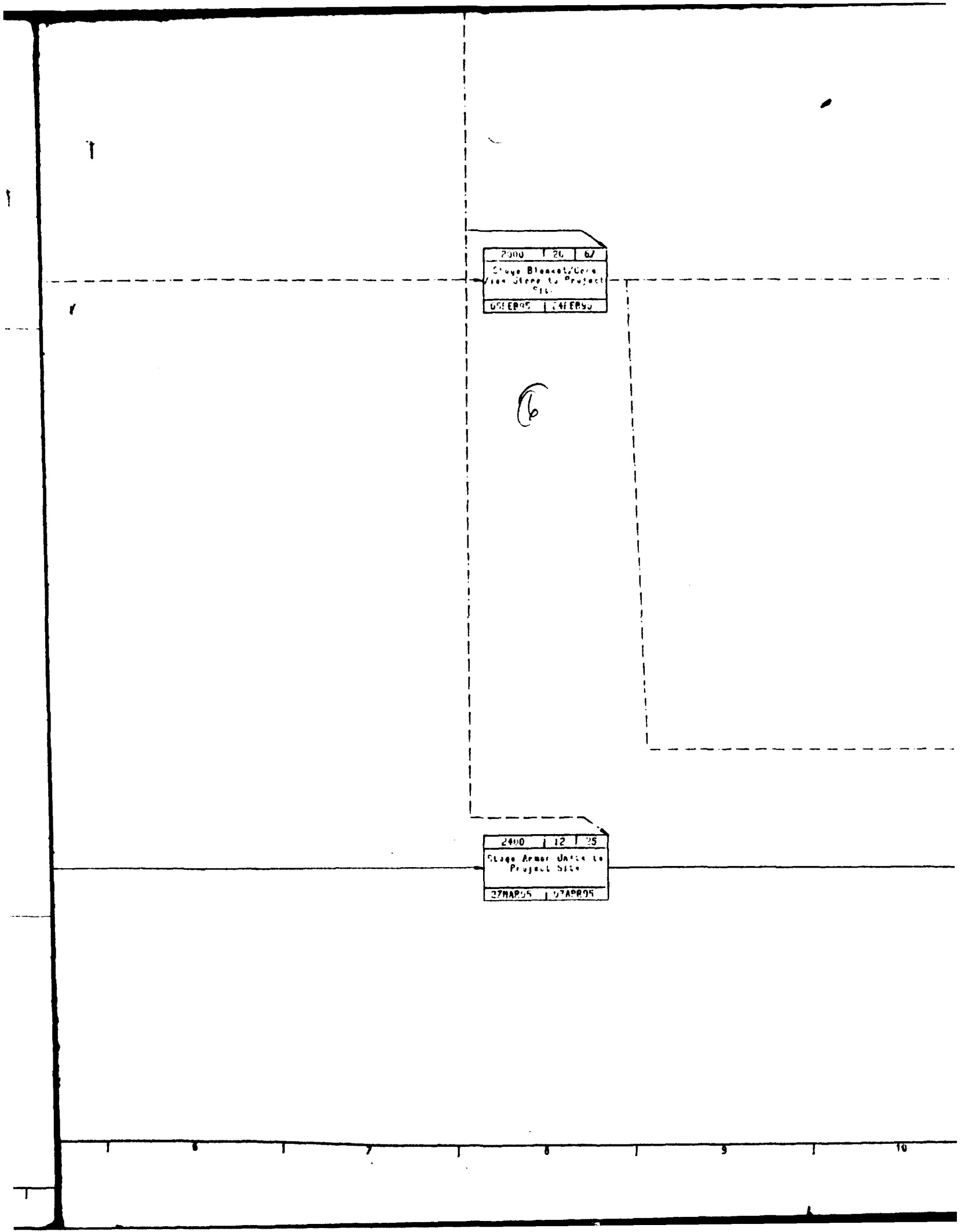

300 | 5 | 33
Prep & Submit Stone Supply Submittals
05JAN95 | 05JAN95
1350 | 15 | 33
COE Review & Approve Stone Suppliers
06JAN95 | 20JAN95
1350 | 2 | 33
Release Purchase Orders to Stone Suppliers
21JAN95 | 23JAN95

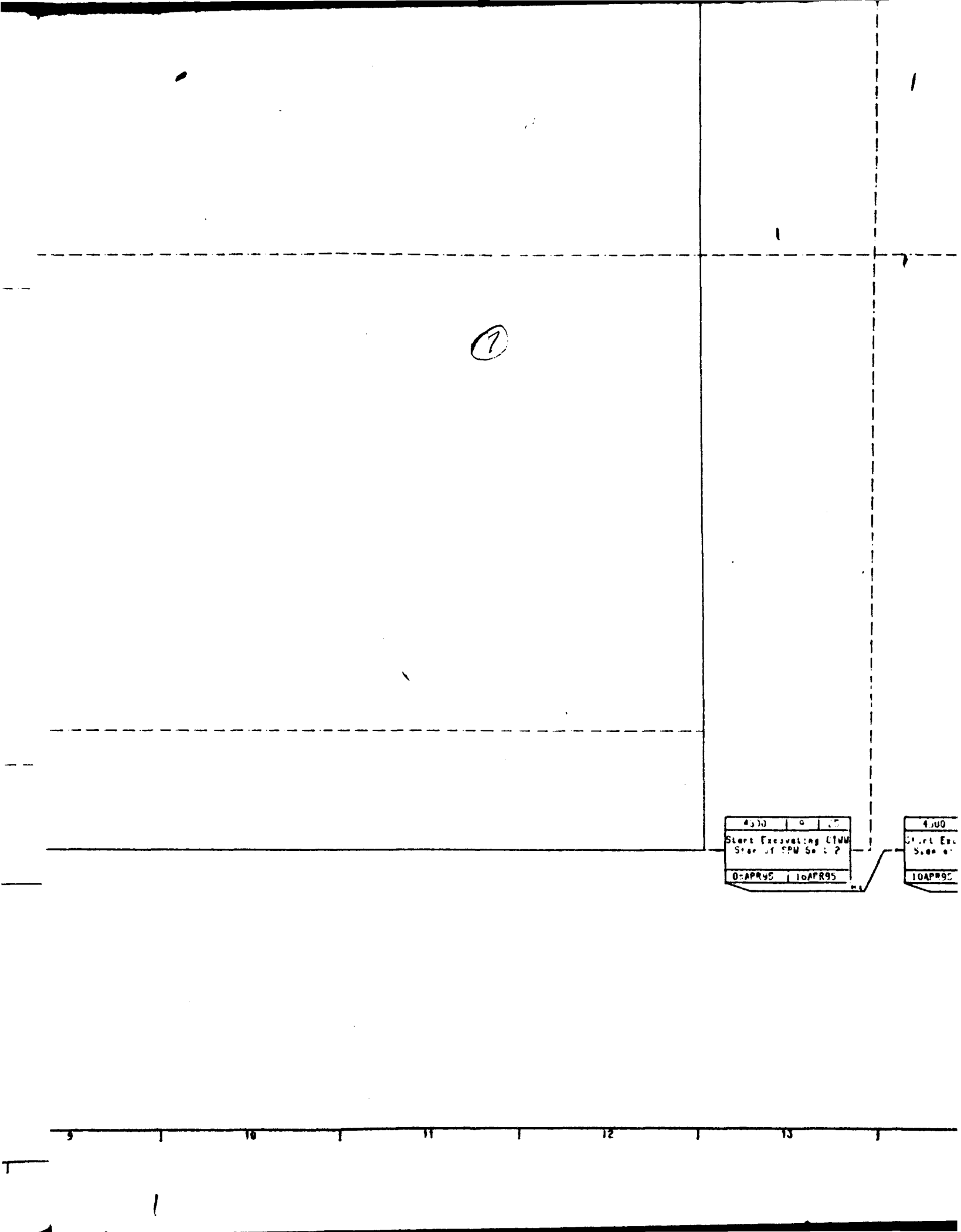

A
B
C
D
1900 | 1 | 43
Redeploy Floating Facility East to MF1
31JAN95
2500 | 5 | 43
Make Improvements to Mooring for Facility 1
01FEB95 | 05FEB95
2300 | 10 | 43
Stage Heavy Construction Equipment to MF1
06FEB95 | 15FEB95
300 | 5 | 43
Develop Staging Area
20FEB95
2600 | 20 | 37
Stage Haul Road Select Fill to Project Site
23JAN95 | 11FEB95
2200 | 20 | 67
Stage Bunkering &

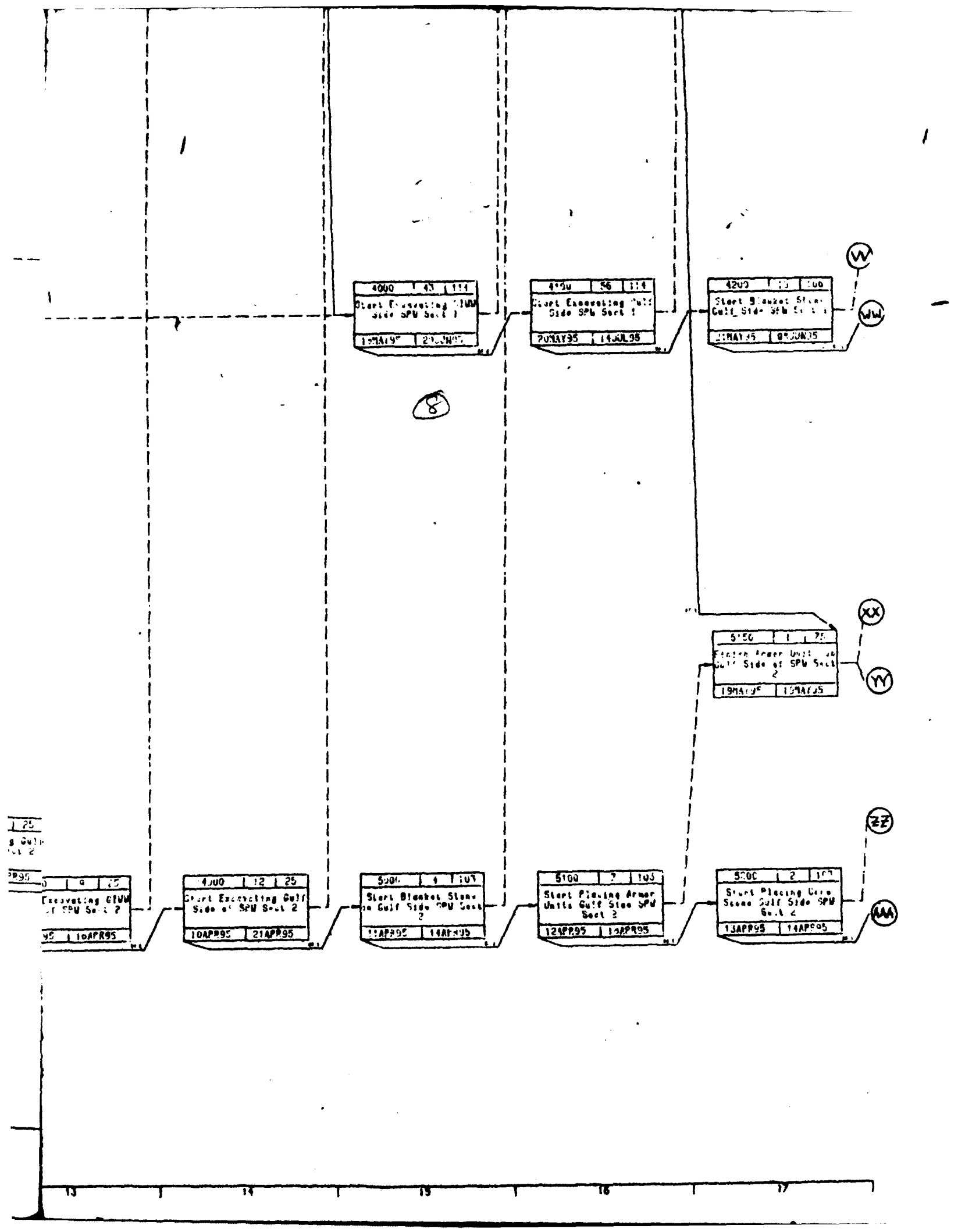

D
E
F
G
H
3400 | 20 | 34
3400 | 23 | 34

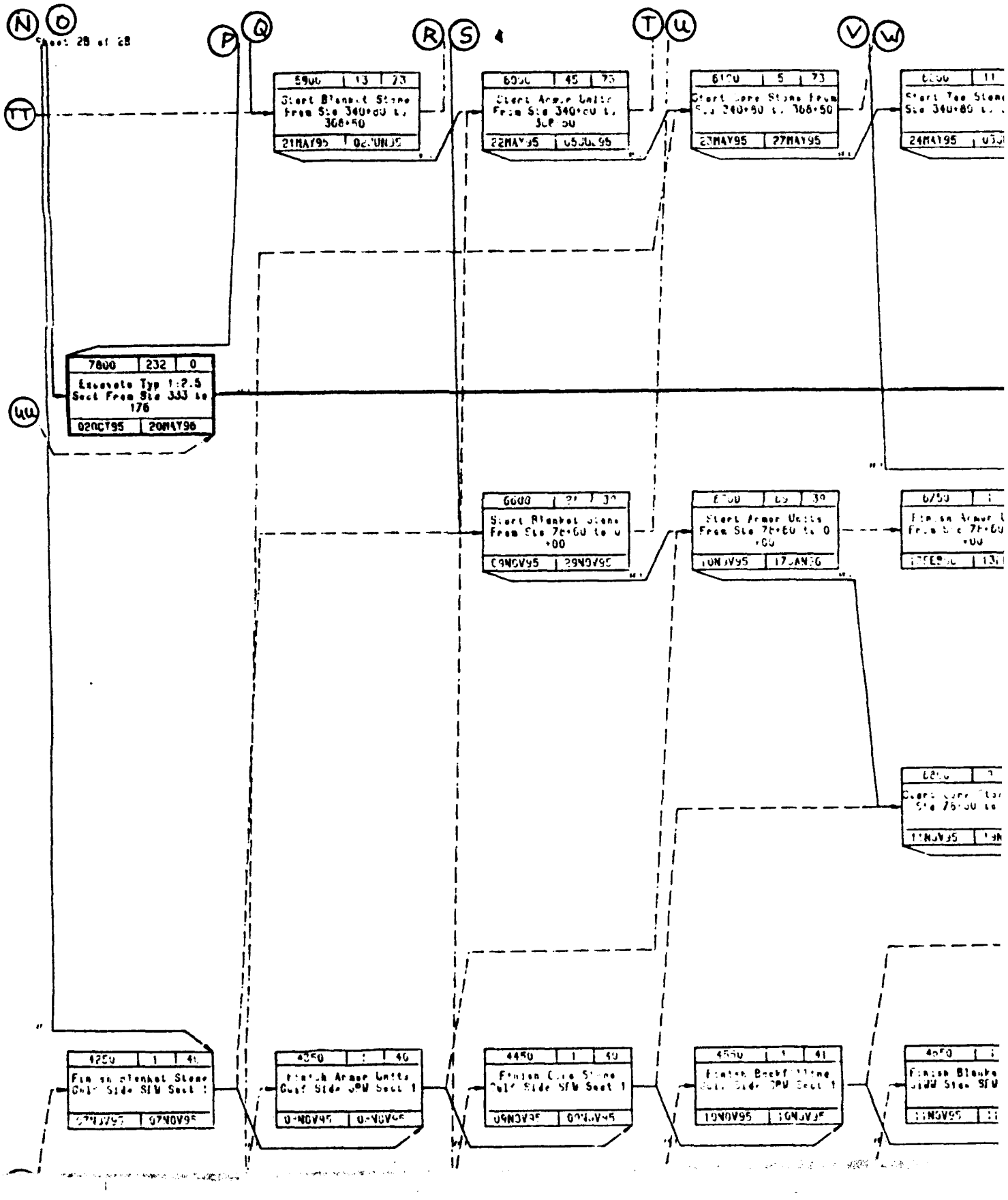

4
H
I
J
K
L
M
TT
UU
W
WW
4000
Side SPW Sect 1
Start Excavating
Side SPW Sect 1
20MAY95
14JUL95
4200
Start Blanket Stone

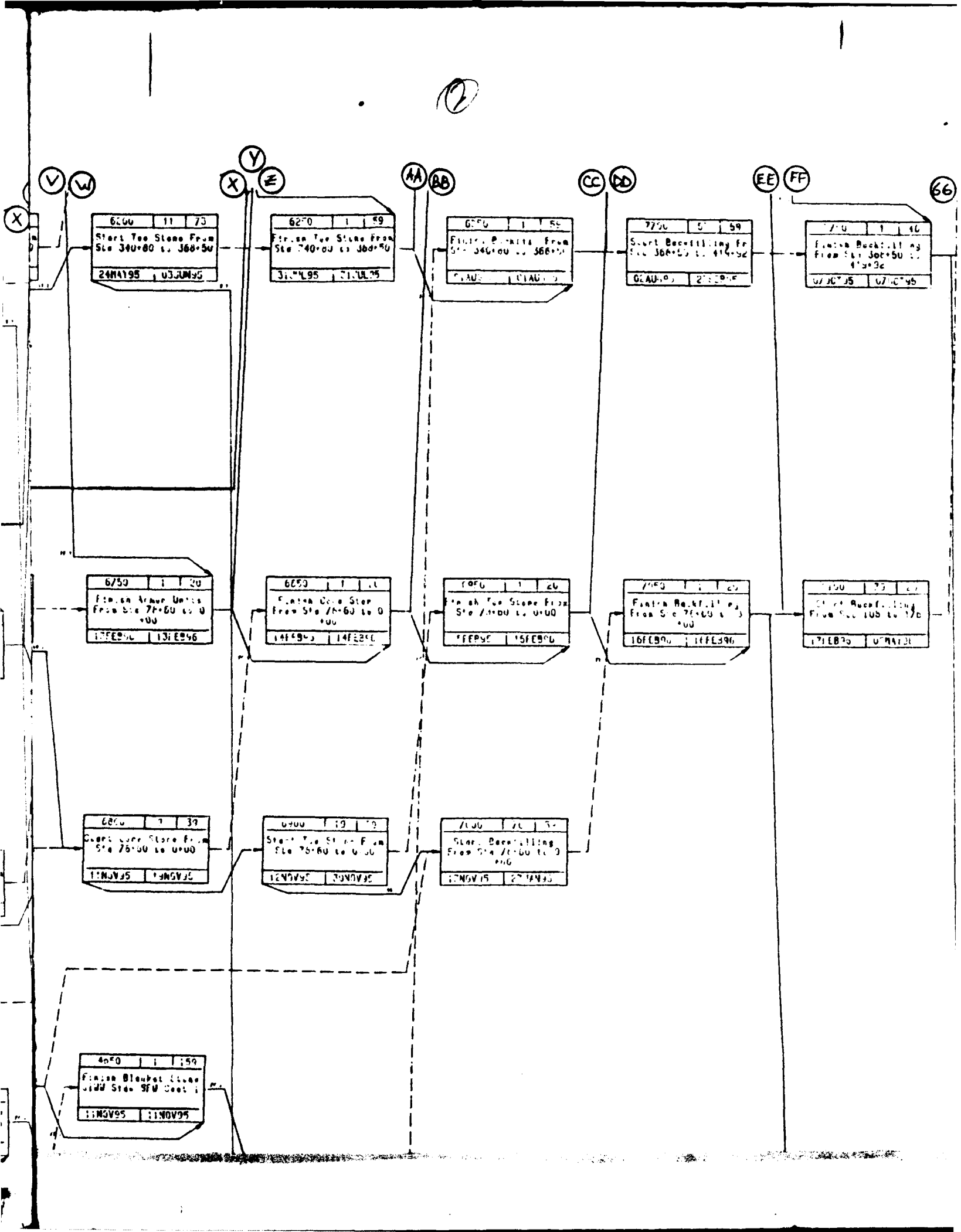

700 | 5 | 33
Prep & Submit Stone Supply Submittals
01JAN95 | 05JAN95
1200 | 15 | 33
COE Review & Approve Stone Suppliers
06JAN95 | 20JAN95
1350 | 2 | 33
Release Purchase Order to Stone Suppliers
21JAN95 | 23JAN95
400 | 10 | 25
Prep & Submit Precast Plant Plans
01JAN95 | 10JAN95
1200 | 15 | 25
COE Review & Approve Precast Plant Plans
11JAN95 | 25JAN95
300 | 5 | 90
Prep & Submit Armor Unit Shop Drawings
01JAN95 | 05JAN95
1100 | 15 | 90
COE Review & Approve Armor Unit Shop Drawings
06JAN95 | 20JAN95
1500 | 60 | 25
Establish Precast Plant
26JAN95 | 29MAR95
500 | 10 | 515
Prep & Submit Preliminary Schedule
01JAN95 | 10JAN95
600 | 40 | 485
Prep & Submit Initial Schedule
01JAN95 | 09FEB95


2000 | 20 | 67
Stage Blankets/Bere
Mats Steel to Project
Site
05FEB95 | 24FEB95
6
2000 | 12 | 25
Stage Armor Units to
Project Site
27MAR95 | 07APR95
6
7
8
9
10

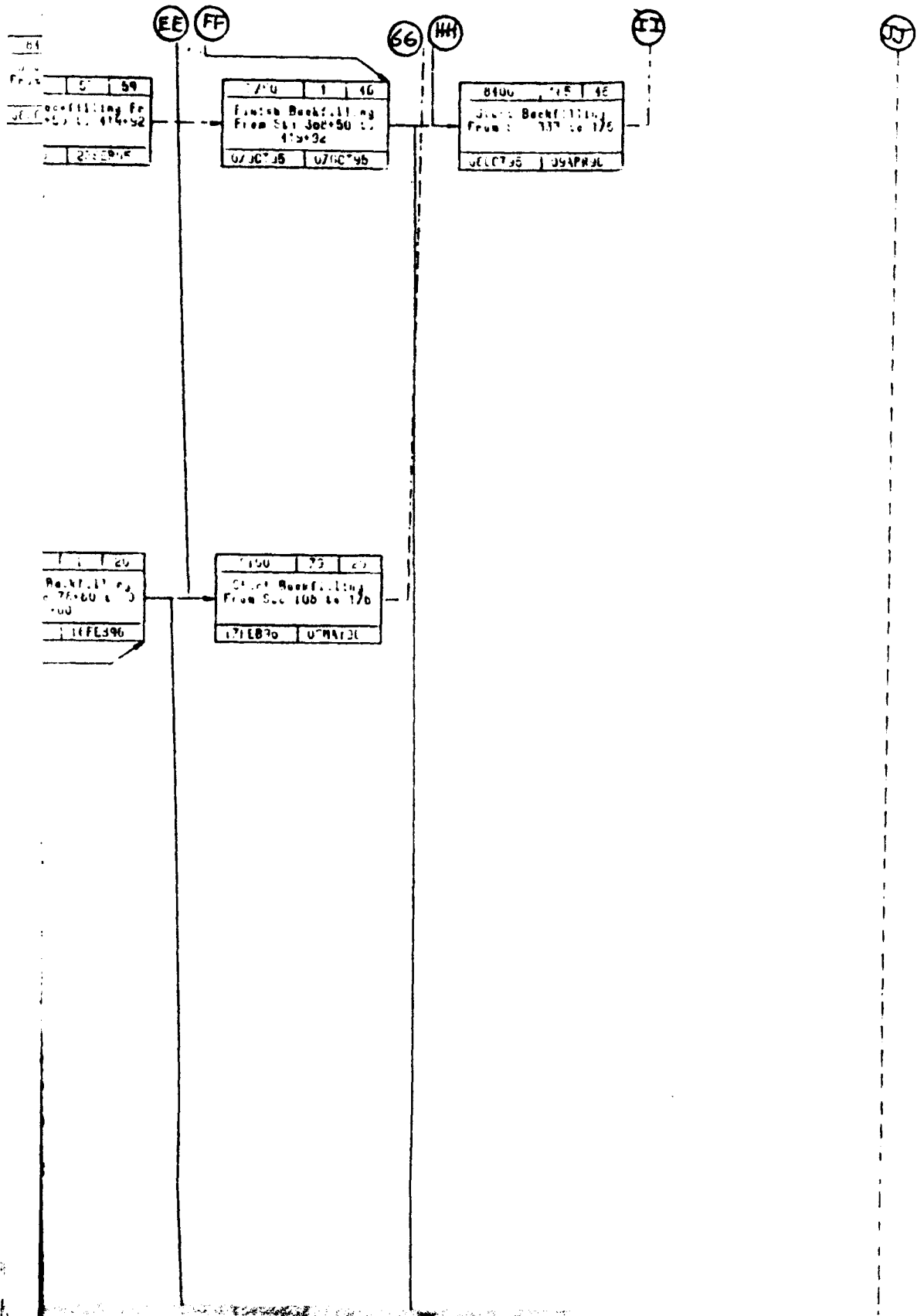

7
4300 | 0 | 15
Start Excavating CIVW
Start of SPW Sec 2
0:APR95 | 10APR95
4300
10APR95
9
10
11
12
13


4000 | 43 | 111
Start Excavating GTMM Side SPM Sect 1
19MAY95 | 20JUN95
4000 | 56 | 114
Start Excavating Gulf Side SPM Sect 1
20MAY95 | 14JUL95
4200 | 33 | 100
Start Blanket Stone Gulf Side SPM Sect 1
21MAY95 | 09JUN95
W
WW
5150 | 1 | 75
Erect Armor Units on Gulf Side of SPM Sect 2
19MAY95 | 19MAY95
XX
YY
4000 | 9 | 25
Excavating GTMM SPM Sect 2
10APR95
4000 | 12 | 25
Start Excavating Gulf Side of SPM Sect 2
10APR95 | 21APR95
5000 | 4 | 103
Start Blanket Stone Gulf Side SPM Sect 2
11APR95 | 14APR95
5100 | 7 | 103
Start Placing Armor Units Gulf Side SPM Sect 2
12APR95 | 18APR95
5200 | 2 | 103
Start Placing Core Stone Gulf Side SPM Sect 2
13APR95 | 14APR95
ZZ
AAA
8
13
14
15
16
17


N
O
P
Q
R
S
T
U
V
W
TT
UU
Sheet 28 of 28
5900 | 13 | 73
Start Blanket Stone From Sta 340+00 to 368+50
21MAY95 | 02JUN95
6000 | 45 | 75
Start Armor Units From Sta 340+00 to 368+50
22MAY95 | 05JUN95
6100 | 5 | 73
Start Core Stone From Sta 340+50 to 368+50
23MAY95 | 27MAY95
6200 | 11
Start Toe Stone Sta 340+80
24MAY95
7800 | 232 | 0
Excavate Typ 1:2.5 Sect From Sta 343 to 176
02OCT95 | 20MAY96
6000 | 39 | 39
Start Blanket Stone From Sta 76+60 to 0 +00
29NOV95
6100 | 39 | 39
Start Armor Units From Sta 76+60 to 0 +00
17JAN96
6250 | 1 | 41
Finish Blanket Stone Outer Side SPW Sect 1
4350 | 1 | 40
Finish Armor Units Outer Side SPW Sect 1
4450 | 1 | 40
Finish Core Stone Outer Side SPW Sect 1
4550 | 1 | 41
Finish Backfilling Outer Side SPW Sect 1


V
W
X
Y
Z
AA
BB
CC
DD
EE
FF
66
6200 | 11 | 73
Start Tee Stone From Sta 340+80 to 368+50
24MAY95 | 03JUN95
6250 | 1 | 59
Finish Tee Stone From Sta 340+00 to 368+50
31MAY95 | 21JUL95
6250 | 1 | 59
Finish Backfill From Sta 340+00 to 368+50
01AUG95 | 01AUG95
7750 | 57 | 59
Start Backfilling From Sta 368+50 to 414+52
01AUG95 | 21SEP95
7750 | 1 | 16
Finish Backfilling From Sta 368+50 to 414+52
07OCT95 | 07OCT95
6750 | 1 | 20
Finish Armor Units From Sta 76+60 to 0+00
13FEB96 | 13FEB96
6850 | 1 | 11
Finish Core Stone From Sta 76+60 to 0+00
14FEB96 | 14FEB96
7050 | 1 | 26
Finish Tee Stone From Sta 76+60 to 0+00
15FEB96 | 15FEB96
7050 | 1 | 26
Finish Backfilling From Sta 76+60 to 0+00
16FEB96 | 16FEB96
7150 | 33 | 42
Start Backfilling From Sta 105 to 176
17FEB96 | 07MAR96
6850 | 1 | 39
Start Core Stone From Sta 76+60 to 0+00
12NOV95 | 25NOV95
6900 | 10 | 19
Start Tee Stone From Sta 76+60 to 0+00
12NOV95 | 30NOV95
7100 | 21 | 37
Start Backfilling From Sta 76+60 to 0+00
13NOV95 | 27JAN96
4950 | 1 | 59
Finish Blanket Stone Under Sta 9FW Cost 1
13NOV95 | 13NOV95

(3)



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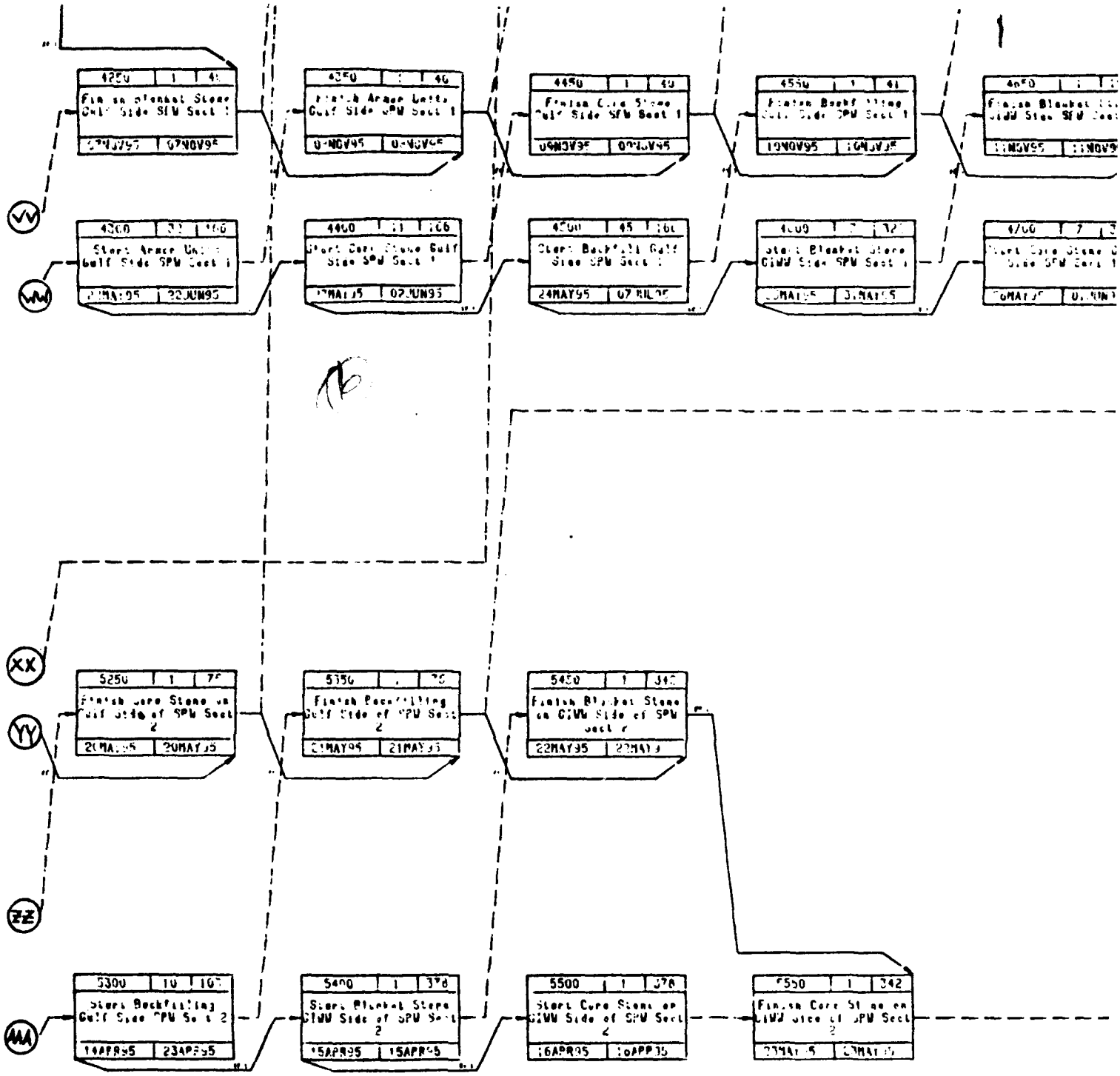
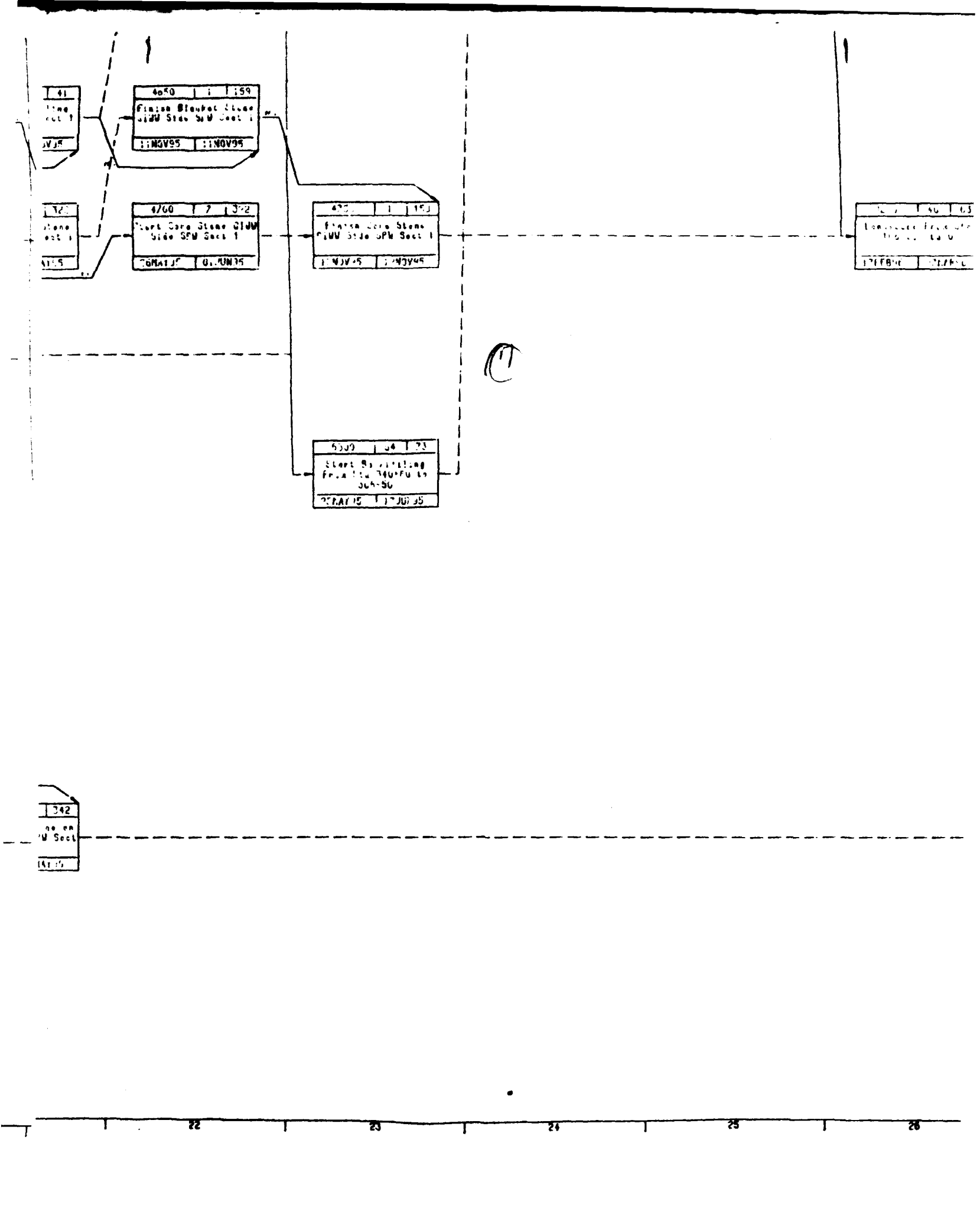
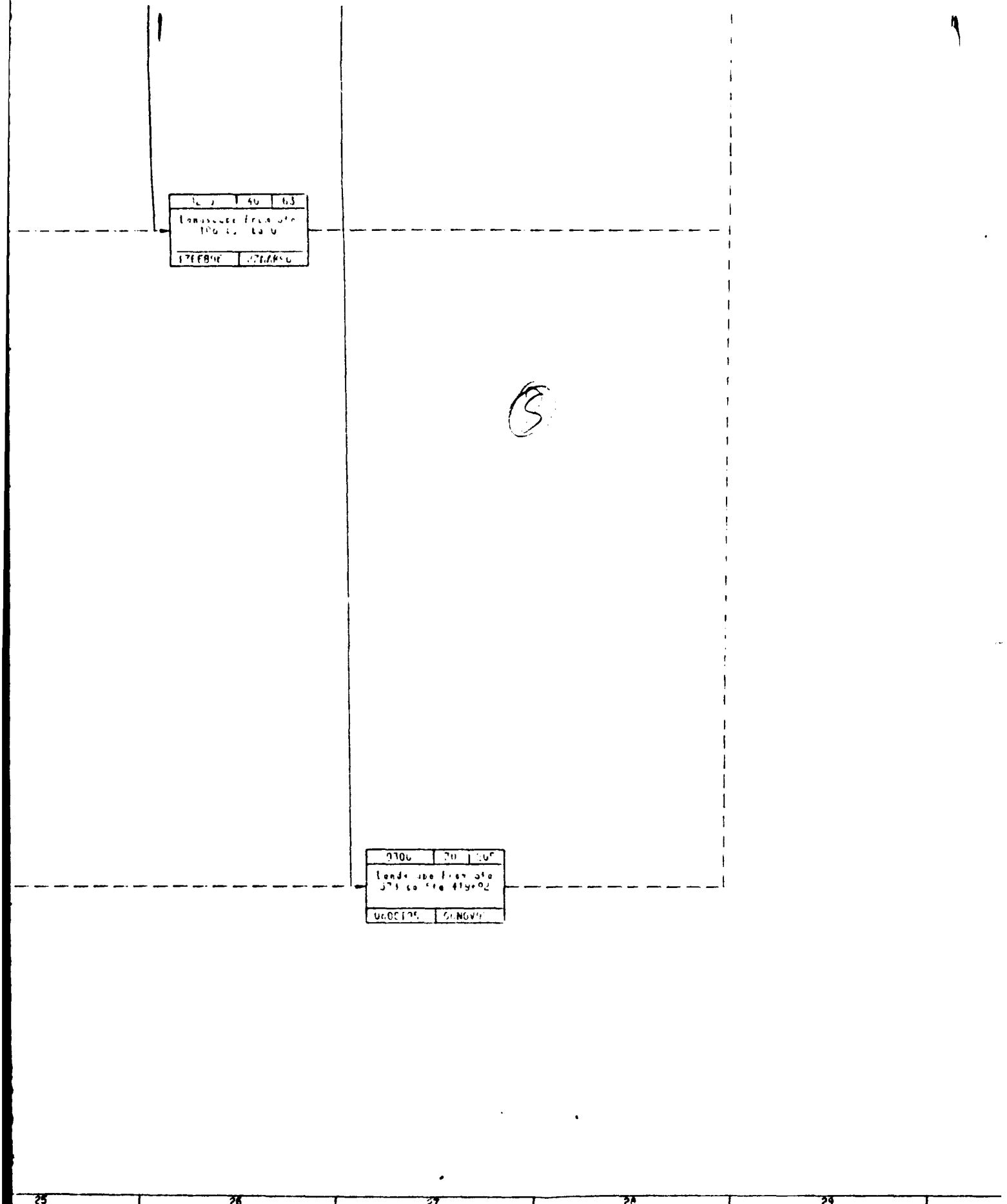
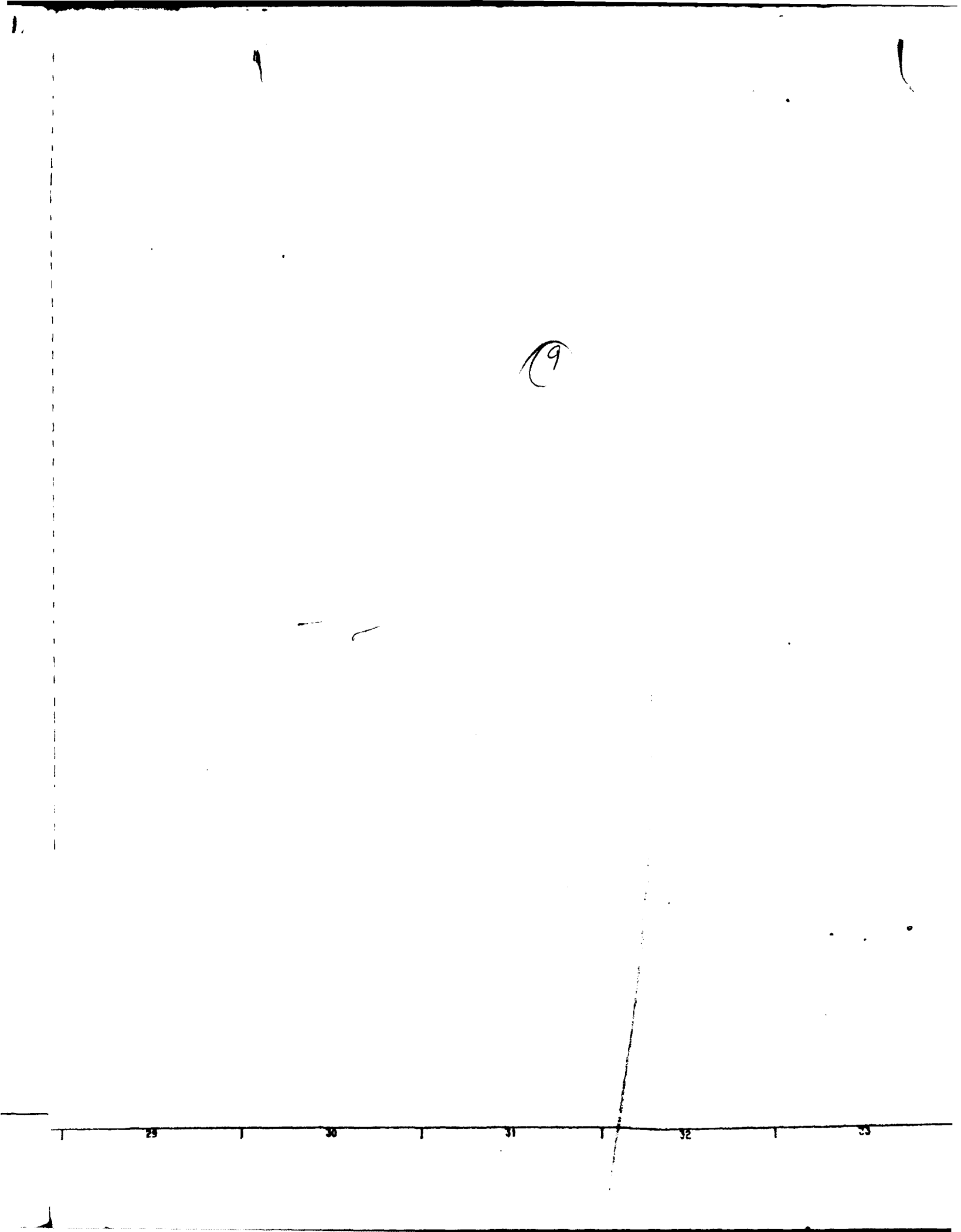
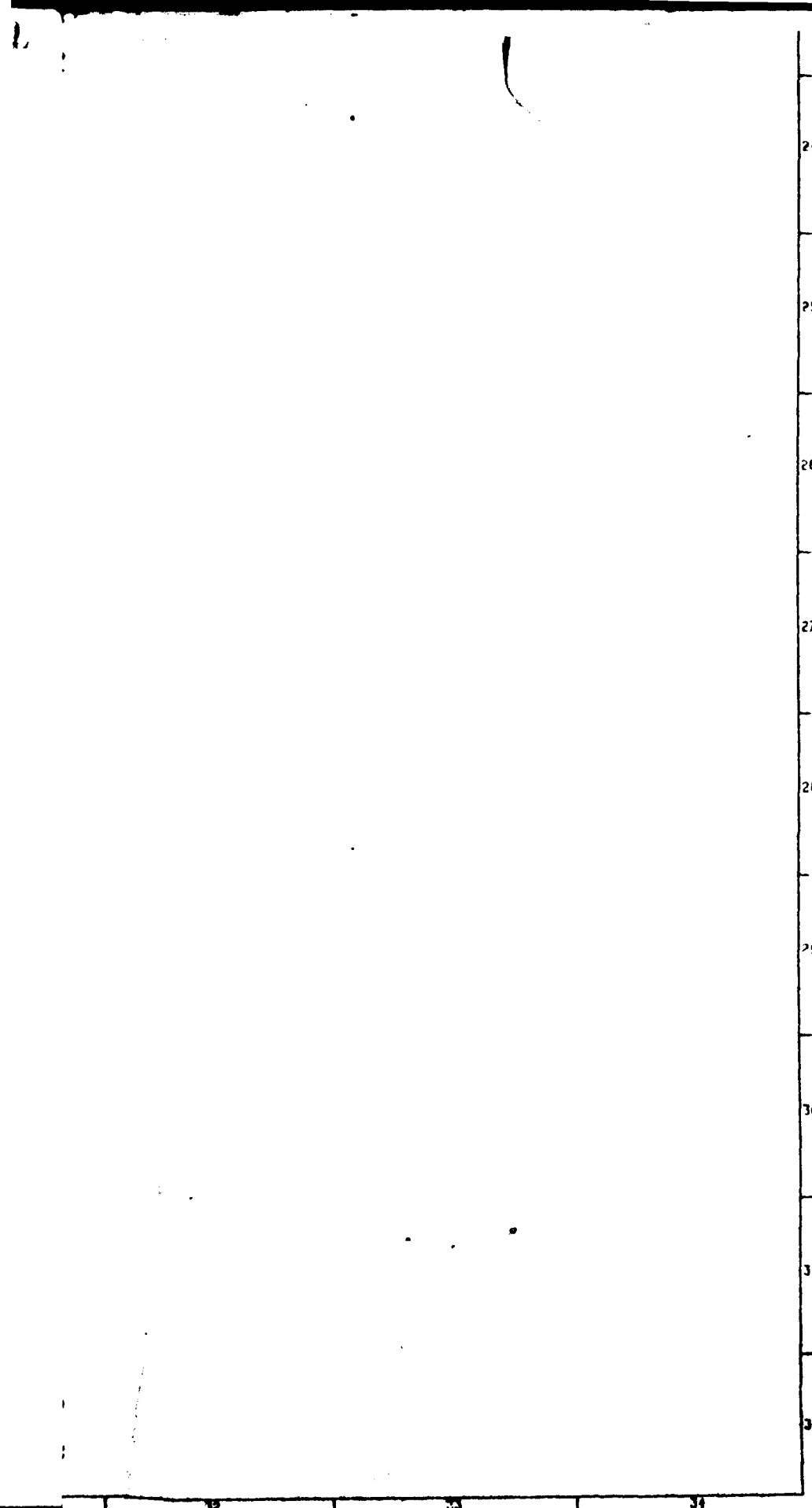

4250
4350
4450
4550
4650
4300
4400
4500
4600
4700
5250
5350
5450
5300
5400
5500
5550
XX
YY
ZZ
AA
16
19
20
21
22


22
23
24
25
26

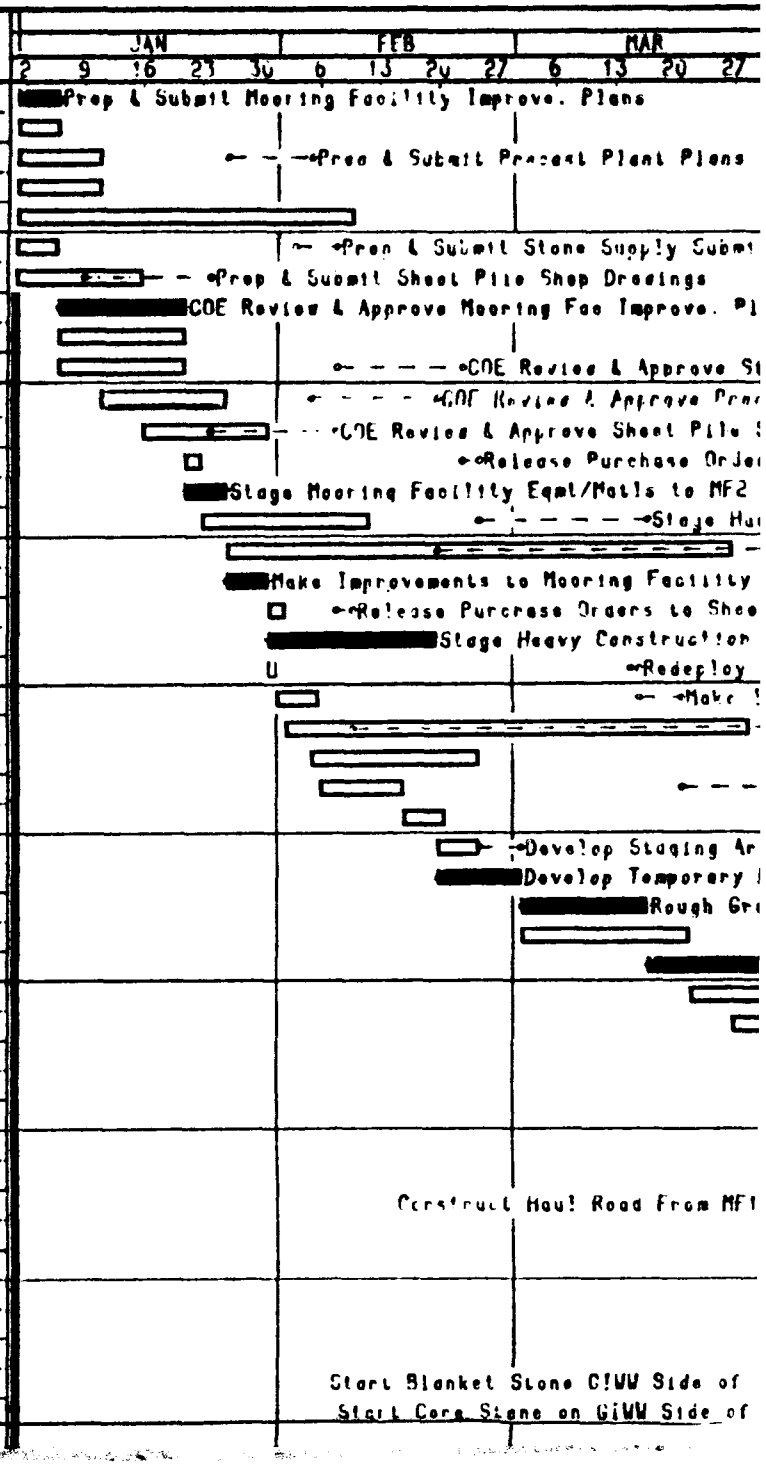

40
63
0700
30
25
26
27
28
29

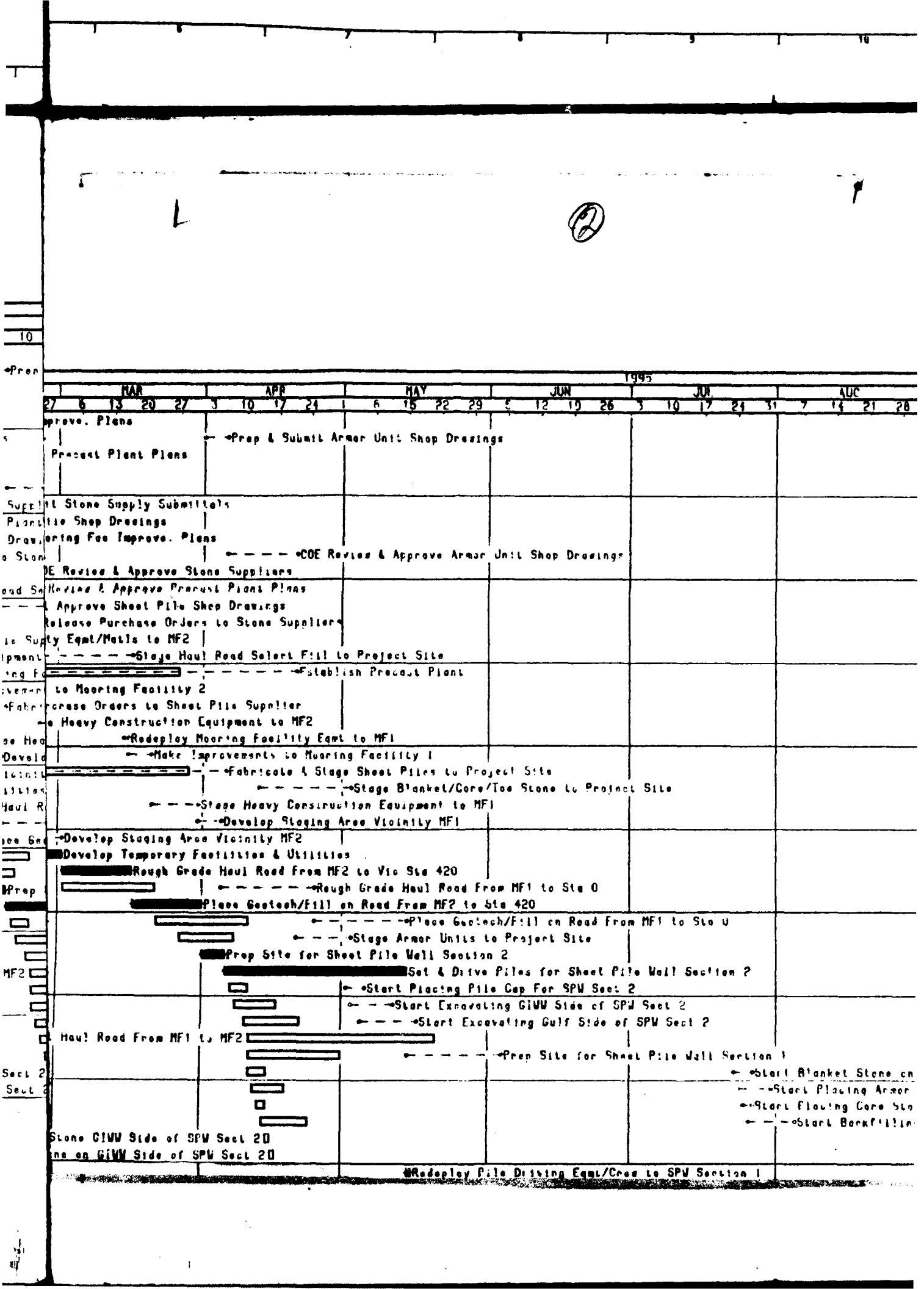

29
30
31
32
33

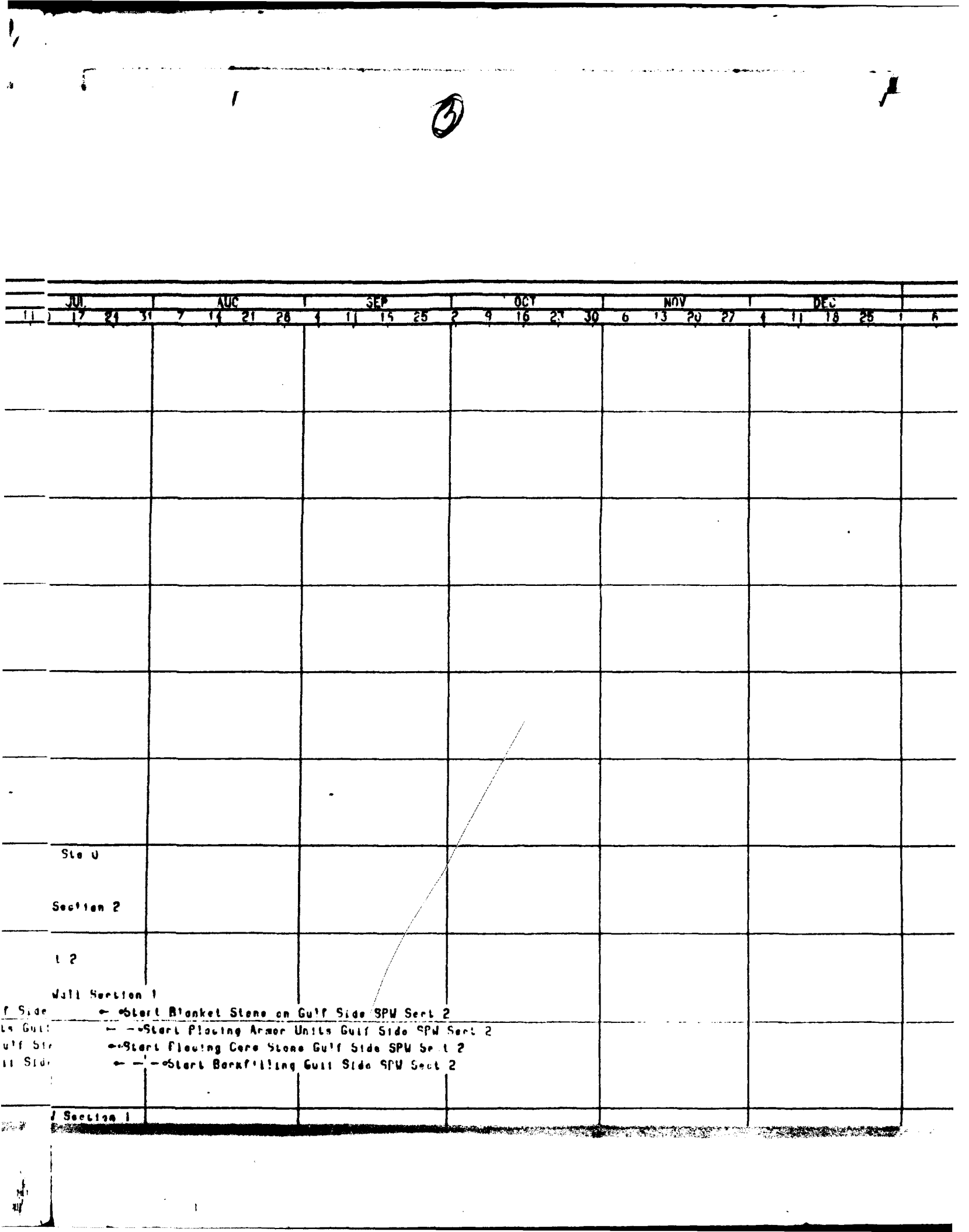


110.

ACTIVITY ID	EARLY START	EARLY FINISH	REM DUR	PCT
200	1JAN95	5JAN95	5	0
300	1JAN95	5JAN95	5	0
400	1JAN95	10JAN95	10	0
500	1JAN95	10JAN95	10	0
600	1JAN95	9FEB95	40	0
700	1JAN95	5JAN95	5	0
900	1JAN95	15JAN95	15	0
1000	6JAN95	20JAN95	15	0
1100	6JAN95	20JAN95	15	0
1300	6JAN95	20JAN95	15	0
1200	11JAN95	25JAN95	15	0
1400	16JAN95	30JAN95	15	0
1350	21JAN95	22JAN95	2	0
1500	21JAN95	25JAN95	5	0
2600	23JAN95	11FEB95	20	0
1600	26JAN95	26MAR95	60	0
1700	26JAN95	30JAN95	5	0
1450	31JAN95	1FEB95	2	0
1800	31JAN95	19FEB95	20	0
1900	31JAN95	31JAN95	1	0
2500	1FEB95	5FEB95	5	0
2100	2FEB95	23MAR95	55	0
2000	5FEB95	24FEB95	20	0
2800	6FEB95	15FEB95	10	0
3000	16FEB95	20FEB95	5	0
2200	20FEB95	24FEB95	5	0
2300	20FEB95	1MAR95	10	0
2700	2MAR95	16MAR95	15	0
3200	2MAR95	21MAR95	20	0
2900	17MAR95	31MAR95	15	0
3400	22MAR95	10APR95	20	0
2400	27MAR95	7APR95	12	0
3100	1APR95	5APR95	5	0
3300	6APR95	14MAY95	39	0
3500	7APR95	10APR95	4	0
4600	8APR95	16APR95	3	0
4000	10APR95	21APR95	12	0
3600	11APR95	20MAY95	40	0
3700	11APR95	30APR95	20	0
5000	11APR95	14APR95	4	0
5100	12APR95	19APR95	7	0
5200	13APR95	14APR95	2	0
5300	14APR95	23APR95	10	0
5400	15APR95	15APR95	1	0
5500	16APR95	16APR95	1	0
1450	15MAY95	15MAY95	1	0




1995
MAR
APR
MAY
JUN
JUL
AUG
27 6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 3 10 17 24 31 7 14 21 28
Prep & Submit Armor Unit Shop Drawings
Precast Plant Plans
COE Review & Approve Armor Unit Shop Drawings
Stage Haul Road Select Fill to Project Site
Establish Precast Plant
Redeploy Mooring Facility Eqmt to MF1
Make Improvements to Mooring Facility 1
Fabricate & Stage Sheet Piles to Project Site
Stage Blanket/Core/Toe Stone to Project Site
Stage Heavy Construction Equipment to MF1
Develop Staging Area Vicinity MF1
Develop Staging Area Vicinity MF2
Develop Temporary Facilities & Utilities
Rough Grade Haul Road From MF2 to Vic Sta 420
Rough Grade Haul Road From MF1 to Sta 0
Place Geotech/Fill on Road From MF2 to Sta 420
Place Geotech/Fill on Road From MF1 to Sta 0
Stage Armor Units to Project Site
Prep Site for Sheet Pile Wall Section 2
Set & Drive Piles for Sheet Pile Wall Section 2
Start Placing Pile Cap For SPW Sect 2
Start Excavating GIWW Side of SPW Sect 2
Start Excavating Gulf Side of SPW Sect 2
Haul Road From MF1 to MF2
Prep Site for Sheet Pile Wall Section 1
Redeploy Pile Driving Eqmt/Crew to SPW Section 1


JUL
AUG
SEP
OCT
NOV
DEC
11 17 24 31 7 14 21 28 4 11 15 25 2 9 16 27 30 6 13 20 27 4 11 18 25 1 8
Ste U
Section 2
t 2
Wall Section 1
f Side
ls Gulf
ulf Sid
ll Side
Start Blanket Stone on Gulf Side SPW Sect 2
Start Placing Armor Units Gulf Side SPW Sect 2
Start Placing Core Stone Gulf Side SPW Sect 2
Start Backfilling Gulf Side SPW Sect 2
/ Section 1

(4)

TIME

DEC			JAN					FEB					MAR					APR					MAY				JUN
22	11	18	25	1	8	15	22	29	5	12	19	26	4	11	18	25	1	8	15	22	29	6	13	20	27	3

5100	12APR95	19APR95	7	0
5200	13APR95	14APR95	2	0
5300	14APR95	23APR95	10	0
5400	15APR95	15APR95	1	0
5500	16APR95	16APR95	1	0
3450	15MAY95	15MAY95	1	0
3550	15MAY95	15MAY95	1	0
3600	16MAY95	2NOV95	171	0
4850	16MAY95	16MAY95	1	0
3900	17MAY95	6JUN95	21	0
4950	17MAY95	17MAY95	1	0
4000	18MAY95	29JUN95	43	0
5050	18MAY95	18MAY95	1	0
5000	18MAY95	25JUL95	69	0
5150	19MAY95	19MAY95	1	0
5700	19MAY95	8JUN95	21	0
4100	20MAY95	14JUL95	56	0
5250	20MAY95	20MAY95	1	0
5800	20MAY95	23MAY95	4	0
4200	21MAY95	6JUN95	19	0
5350	21MAY95	21MAY95	1	0
5900	21MAY95	2JUN95	13	0
4300	22MAY95	22JUN95	32	0
5450	22MAY95	22MAY95	1	0
6000	22MAY95	5JUL95	45	0
4400	23MAY95	2JUN95	11	0
5550	23MAY95	23MAY95	1	0
6100	23MAY95	27MAY95	5	0
4500	24MAY95	7JUL95	45	0
6200	24MAY95	3JUN95	11	0
4600	25MAY95	31MAY95	7	0
6300	25MAY95	17JUL95	54	0
4700	26MAY95	1JUN95	7	0
5750	26JUL95	26JUL95	1	0
7100	26JUL95	10CT95	68	0
5850	27JUL95	27JUL95	1	0
5950	28JUL95	28JUL95	1	0
7200	28JUL95	2AUG95	6	0
6050	29JUL95	29JUL95	1	0
7300	29JUL95	12AUG95	15	0
6150	30JUL95	30JUL95	1	0
7400	30JUL95	16SEP95	49	0
6250	31JUL95	31JUL95	1	0
7500	31JUL95	5AUG95	6	0
6350	1AUG95	1AUG95	1	0
7600	1AUG95	13AUG95	13	0
7700	2AUG95	23SEP95	53	0
7250	20CT95	20CT95	1	0
7800	20CT95	20MAY96	232	0
7350	30CT95	30CT95	1	0
7900	30CT95	23OCT95	21	0
7450	40CT95	40CT95	1	0
8000	40CT95	21NOV95	49	0
7550	50CT95	50CT95	1	0
8100	50CT95	23MAR96	171	0
7650	60CT95	60CT95	1	0
9200	60CT95	28OCT95	23	0
7750	70CT95	70CT95	1	0

Start Blanket Stone GIWW Side of SPU S
Start Core Stone on GIWW Side of SPU

(5)

Finish Blanket Sto

Finish Core St

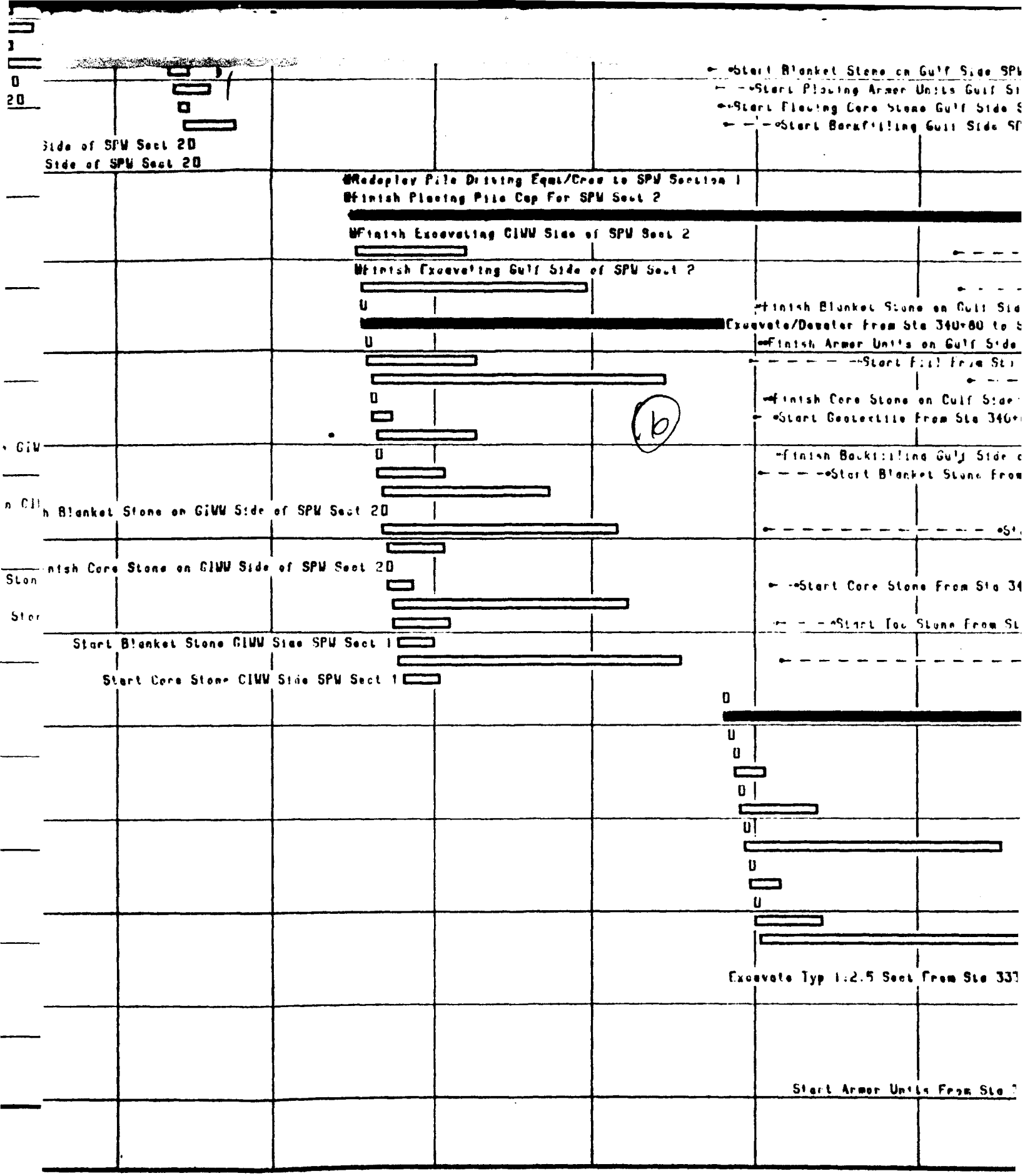
Start Blo

Start

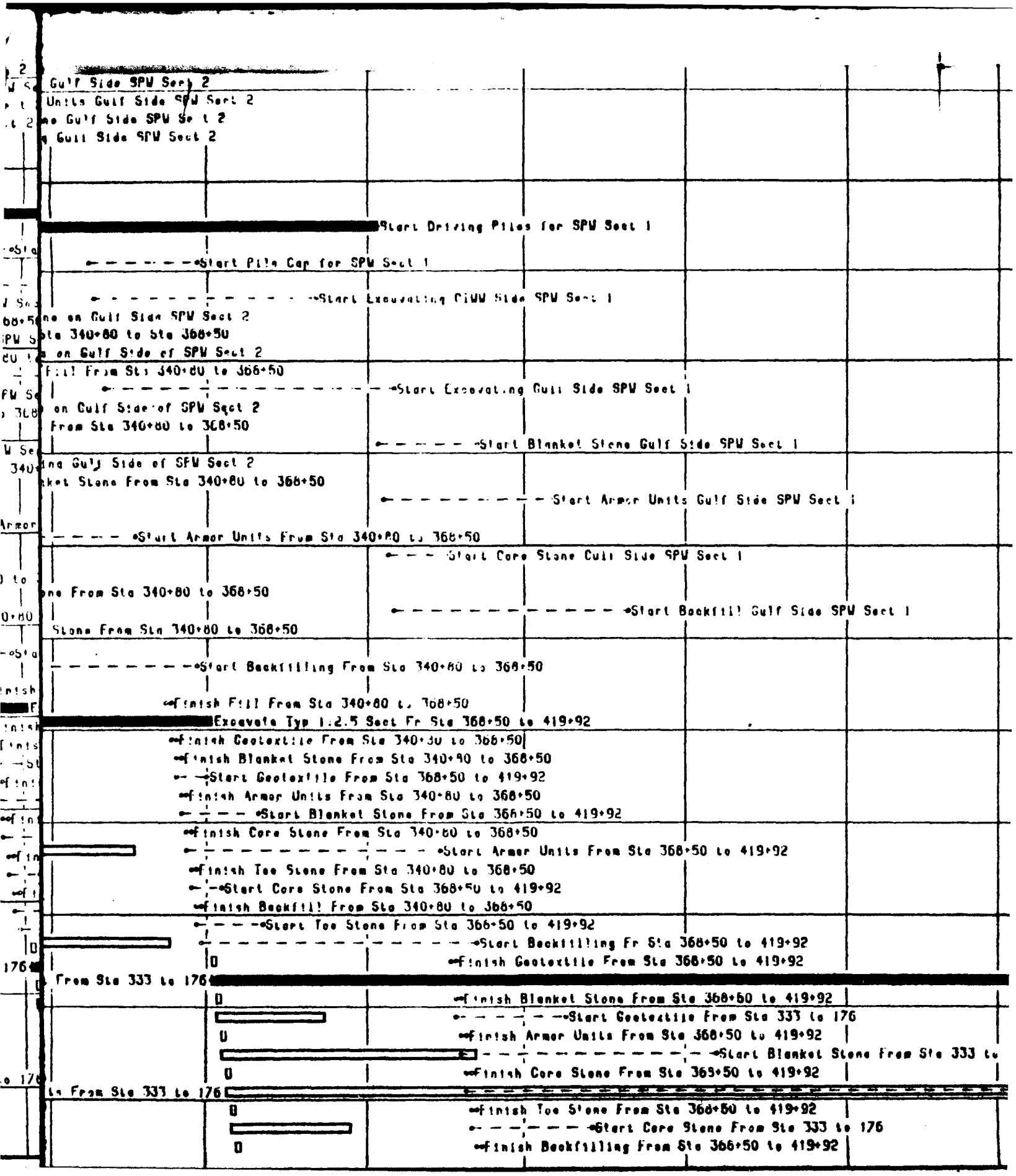
Plot Date 13AUG93
Data Date 1JAN95
Project Start 1JAN95
Project Finish 8JUN96

Activity Bar/Early Dates
Critical Activity
Progress Bar
Activity Late Dates
◇/P Milestone/Flag Activity

SARG



Constructability St
Sargent Beach Revetm
Bar Chart


Gulf Side SPW Sect 2
Units Gulf Side SPW Sect 2
Gulf Side SPW Sect 2
Start Driving Piles for SPW Sect 1
Start Pile Cap for SPW Sect 1
Start Excavating CIWW Side SPW Sect 1
on Gulf Side SPW Sect 2
Sta 340+80 to Sta 368+50
on Gulf Side of SPW Sect 2
Fill From Sta 340+80 to 368+50
Start Excavating Gulf Side SPW Sect 1
on Gulf Side of SPW Sect 2
From Sta 340+80 to 368+50
Start Blanket Stone Gulf Side SPW Sect 1
ing Gulf Side of SPW Sect 2
ket Stone From Sta 340+80 to 368+50
Start Armor Units Gulf Side SPW Sect 1
Start Armor Units From Sta 340+80 to 368+50
Start Core Stone Gulf Side SPW Sect 1
one From Sta 340+80 to 368+50
Start Backfill Gulf Side SPW Sect 1
Stone From Sta 340+80 to 368+50
Start Backfilling From Sta 340+80 to 368+50
Finish Fill From Sta 340+80 to 368+50
Excavate Typ 1:2.5 Sect Fr Sta 368+50 to 419+92
Finish Geotextile From Sta 340+80 to 368+50
Finish Blanket Stone From Sta 340+80 to 368+50
Start Geotextile From Sta 368+50 to 419+92
Finish Armor Units From Sta 340+80 to 368+50
Start Blanket Stone From Sta 368+50 to 419+92
Finish Core Stone From Sta 340+80 to 368+50
Start Armor Units From Sta 368+50 to 419+92
Finish Toe Stone From Sta 340+80 to 368+50
Start Core Stone From Sta 368+50 to 419+92
Finish Backfill From Sta 340+80 to 368+50
Start Toe Stone From Sta 368+50 to 419+92
Start Backfilling Fr Sta 368+50 to 419+92
Finish Geotextile From Sta 368+50 to 419+92
From Sta 333 to 176
Finish Blanket Stone From Sta 368+50 to 419+92
Start Geotextile From Sta 333 to 176
Finish Armor Units From Sta 368+50 to 419+92
Start Blanket Stone From Sta 333 to
Finish Core Stone From Sta 368+50 to 419+92
to From Sta 333 to 176
Finish Toe Stone From Sta 368+50 to 419+92
Start Core Stone From Sta 333 to 176
Finish Backfilling From Sta 368+50 to 419+92

W Sect I

Side SPW Sect I

I

Gulf Side SPW Sect I

419+92

o 419+92
419+92

D to 419+92
Sta 333 to 176
to 419+92
t Blanket Stone From Sta 333 to 176
to 419+92

o 419+92
m Sta 333 to 176
D to 419+92

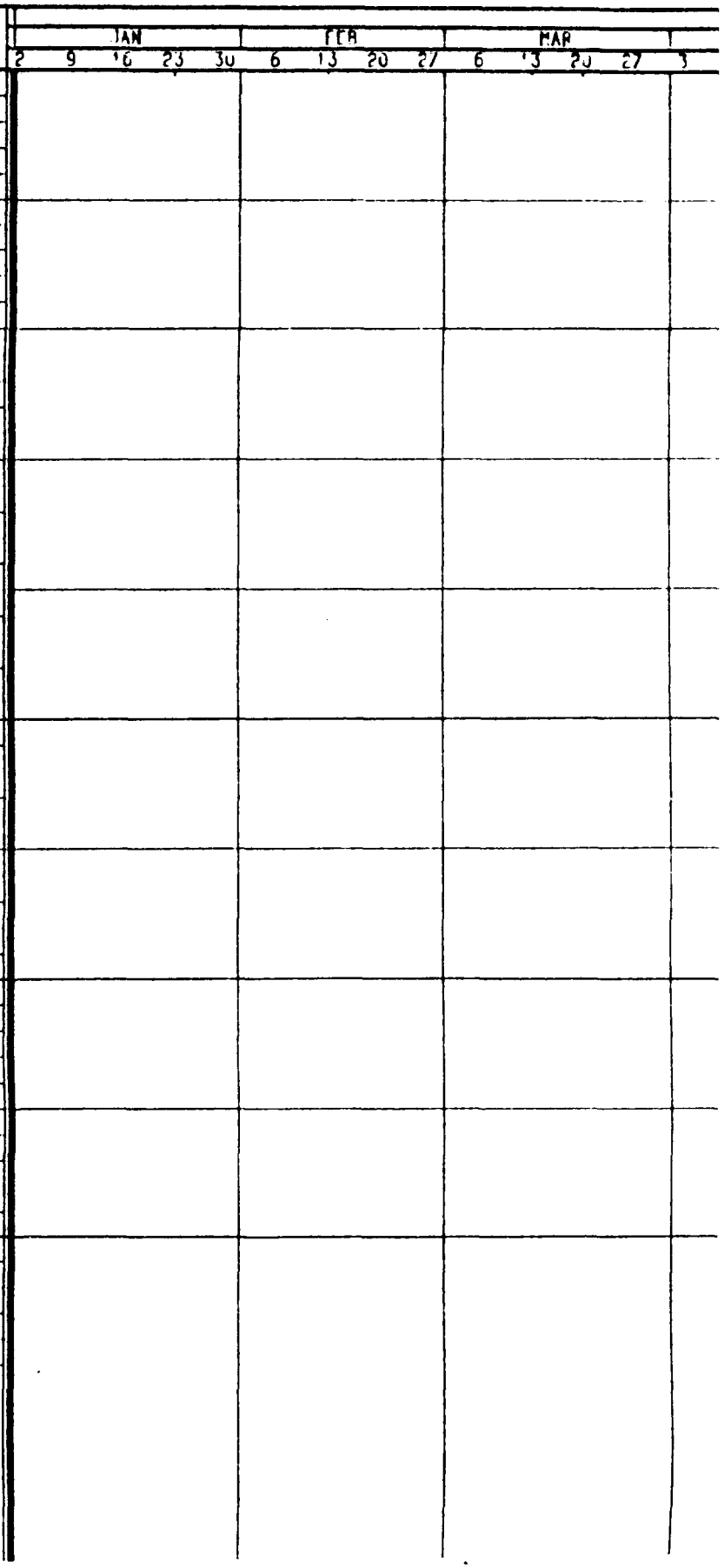
Sheet 1 of 2

8

Date	Revision	Checked	Approved

A:PJ\SBBAR.001

ACTIVITY ID	EARLY START	EARLY FINISH	REM DUR	PCT
6300	7OCT95	22NOV95	47	0
6400	8OCT95	8APR96	185	0
3700	9OCT95	6NOV95	30	0
3850	3NOV95	3NOV95	1	0
3950	4NOV95	4NOV95	1	0
4050	5NOV95	5NOV95	1	0
4150	6NOV95	6NOV95	1	0
4250	7NOV95	7NOV95	1	0
6400	7NOV95	16FEB96	96	0
4350	8NOV95	8NOV95	1	0
6500	8NOV95	16NOV95	7	0
4450	9NOV95	9NOV95	1	0
5000	9NOV95	29NOV95	21	0
4550	10NOV95	10NOV95	1	0
6700	10NOV95	17JAN96	67	0
4650	11NOV95	11NOV95	1	0
6300	11NOV95	13NOV95	3	0
4750	12NOV95	12NOV95	1	0
6900	12NOV95	30NOV95	13	0
7000	13NOV95	27JAN96	76	0
6550	11FEB96	11FEB96	1	0
6500	11FEB96	20MAY96	100	0
6650	12FEB96	12FEB96	1	0
6600	12FEB96	20FEB96	9	0
6750	13FEB96	13FEB96	1	0
8700	13FEB96	4MAR96	21	0
6750	14FEB96	14FEB96	1	0
8300	14FEB96	26APR96	73	0
6850	15FEB96	15FEB96	1	0
8900	15FEB96	23FEB96	9	0
7050	16FEB96	16FEB96	1	0
9000	16FEB96	5MAR96	13	0
9100	17FEB96	5MAY96	77	0
9200	17FEB96	27MAR96	40	0
9400	1MAR96	29MAY96	90	0
7350	21MAY96	21MAY96	1	0
8950	21MAY96	21MAY96	1	0
8650	22MAY96	22MAY96	1	0
8750	22MAY96	22MAY96	1	0
8150	23MAY96	23MAY96	1	0
8650	23MAY96	23MAY96	1	0
8750	24MAY96	24MAY96	1	0
8850	24MAY96	24MAY96	1	0
8350	25MAY96	25MAY96	1	0
8950	25MAY96	25MAY96	1	0
8450	26MAY96	26MAY96	1	0
8750	26MAY96	26MAY96	1	0
9550	30MAY96	5JUN96	5	0
9000	30MAY96	5JUN96	5	0
9700	4JUN96	8JUN96	5	0



APR
'7

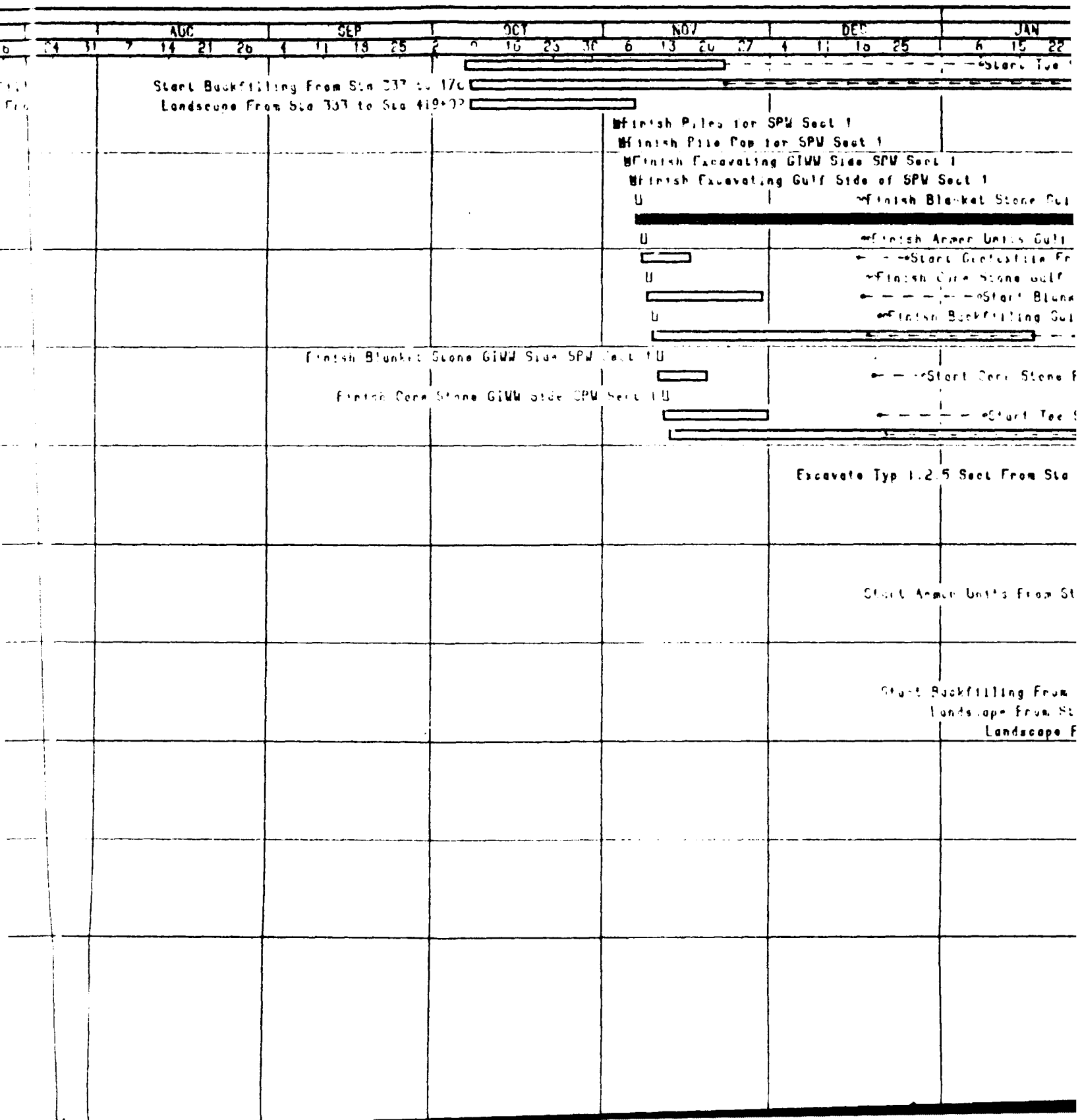
(2)

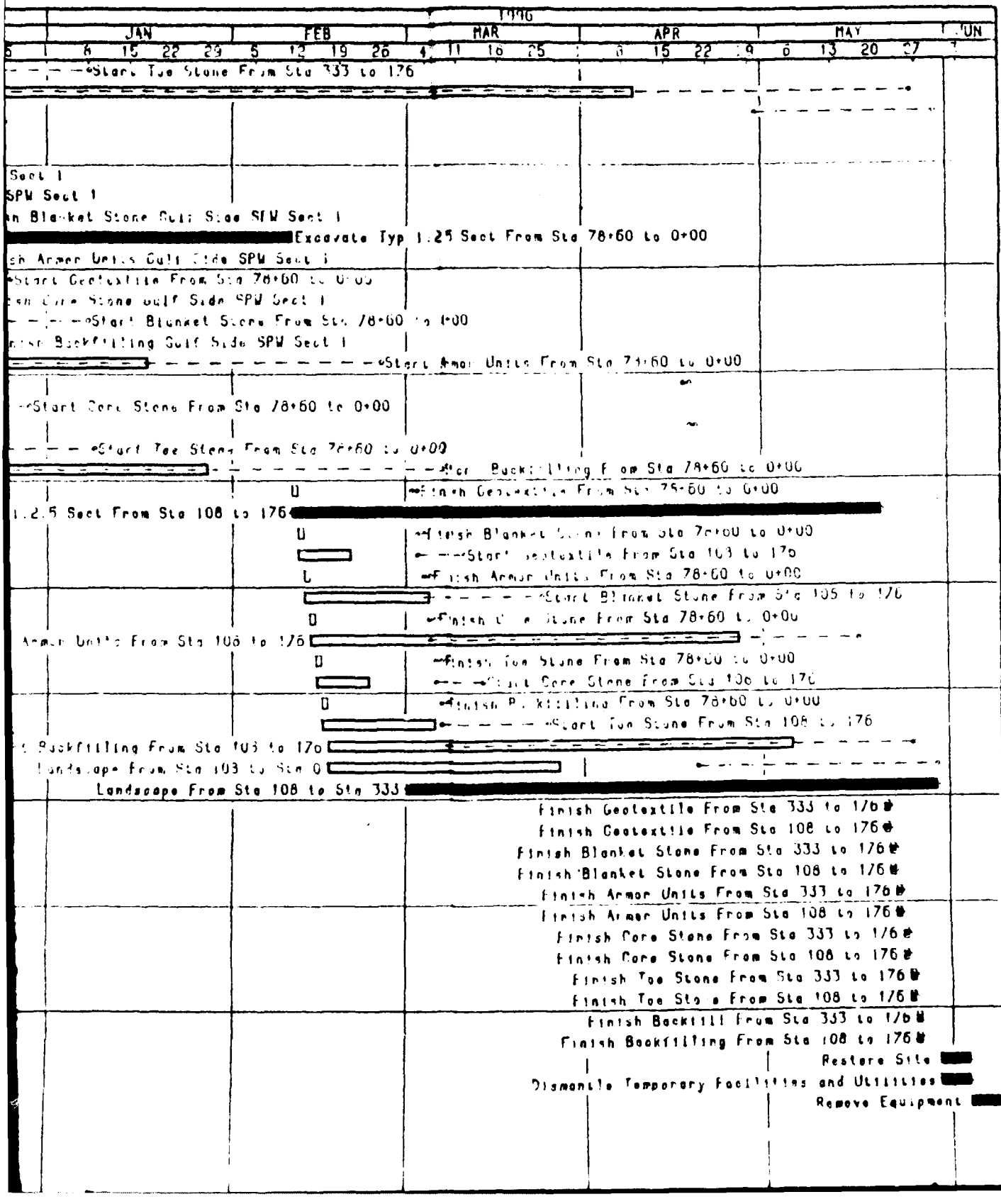
1995

FEB	MAR	APR	MAY	JUN	JUL	AUG
20 27	6 13 20 27	3 10 17 24	8 15 22 29	5 12 19 26	3 10 17 24 31	7 14

Start
Lands

1 (13) 1


AUG
SEP
OCT
NOV
DEC
JAN
24 31 7 14 21 26 4 11 19 25 2 9 16 23 30 6 13 20 27 4 11 18 25 6 15 22
Start Backfilling From Sta 337 to 176
Landscape From Sta 337 to Sta 419+00
Finish Piles for SPW Sect 1
Finish Pile Cap for SPW Sect 1
Finish Excavating GIWW Side SPW Sect 1
Finish Excavating Gulf Side of SPW Sect 1
U
Finish Blanket Stone Gul
U
Finish Armor Units Gulf
Start Geotextile Fr
U
Finish Core Stone Gulf
Start Blank
U
Finish Backfilling Gul
Finish Blanket Stone GIWW Side SPW Sect 1U
Start Core Stone F
Finish Core Stone GIWW Side SPW Sect 1U
Start Toe S
Excavate Typ 1,2,5 Sect From Sta
Start Armor Units From St
Start Backfilling From
Landscape From St
Landscape F


1996
JAN
FEB
MAR
APR
MAY
JUN
Start Toe Stone From Sta 333 to 176
Excavate Typ 1:25 Sect From Sta 78+60 to 0+00
Start Geotextile From Sta 78+60 to 0+00
Start Blanket Stone From Sta 78+60 to 0+00
Start Armor Units From Sta 78+60 to 0+00
Start Core Stone From Sta 78+60 to 0+00
Start Toe Stone From Sta 78+60 to 0+00
Finish Geotextile From Sta 78+60 to 0+00
Start Geotextile From Sta 108 to 176
Finish Armor Units From Sta 78+60 to 0+00
Start Blanket Stone From Sta 108 to 176
Finish Core Stone From Sta 78+60 to 0+00
Finish Toe Stone From Sta 78+60 to 0+00
Start Core Stone From Sta 108 to 176
Finish Backfilling From Sta 78+60 to 0+00
Start Toe Stone From Sta 108 to 176
Landscape From Sta 108 to Sta 333
Finish Geotextile From Sta 333 to 176
Finish Geotextile From Sta 108 to 176
Finish Blanket Stone From Sta 333 to 176
Finish Blanket Stone From Sta 108 to 176
Finish Armor Units From Sta 333 to 176
Finish Armor Units From Sta 108 to 176
Finish Core Stone From Sta 333 to 176
Finish Core Stone From Sta 108 to 176
Finish Toe Stone From Sta 333 to 176
Finish Toe Stone From Sta 108 to 176
Finish Backfill From Sta 333 to 176
Finish Backfilling From Sta 108 to 176
Restore Site
Dismantle Temporary Facilities and Utilities
Remove Equipment

8650	23MAY96	23MAY96	1	0
8450	24MAY96	24MAY96	1	0
8650	24MAY96	24MAY96	1	0
8350	25MAY96	25MAY96	1	0
8050	25MAY96	25MAY96	1	0
8450	26MAY96	26MAY96	1	0
8150	26MAY96	26MAY96	1	0
9510	30MAY96	3JUN96	5	0
9000	30MAY96	3JUN96	5	0
9700	4JUN96	8JUN96	5	0

15

Plot Date 13AUG93
Data Date 1JAN95
Project Start 1JAN95
Project Finish 8JUN96

Activity Bar/Early Dates
Critical Activity
Progress Bar
Activity Late Dates
Milestone/Flag Activity

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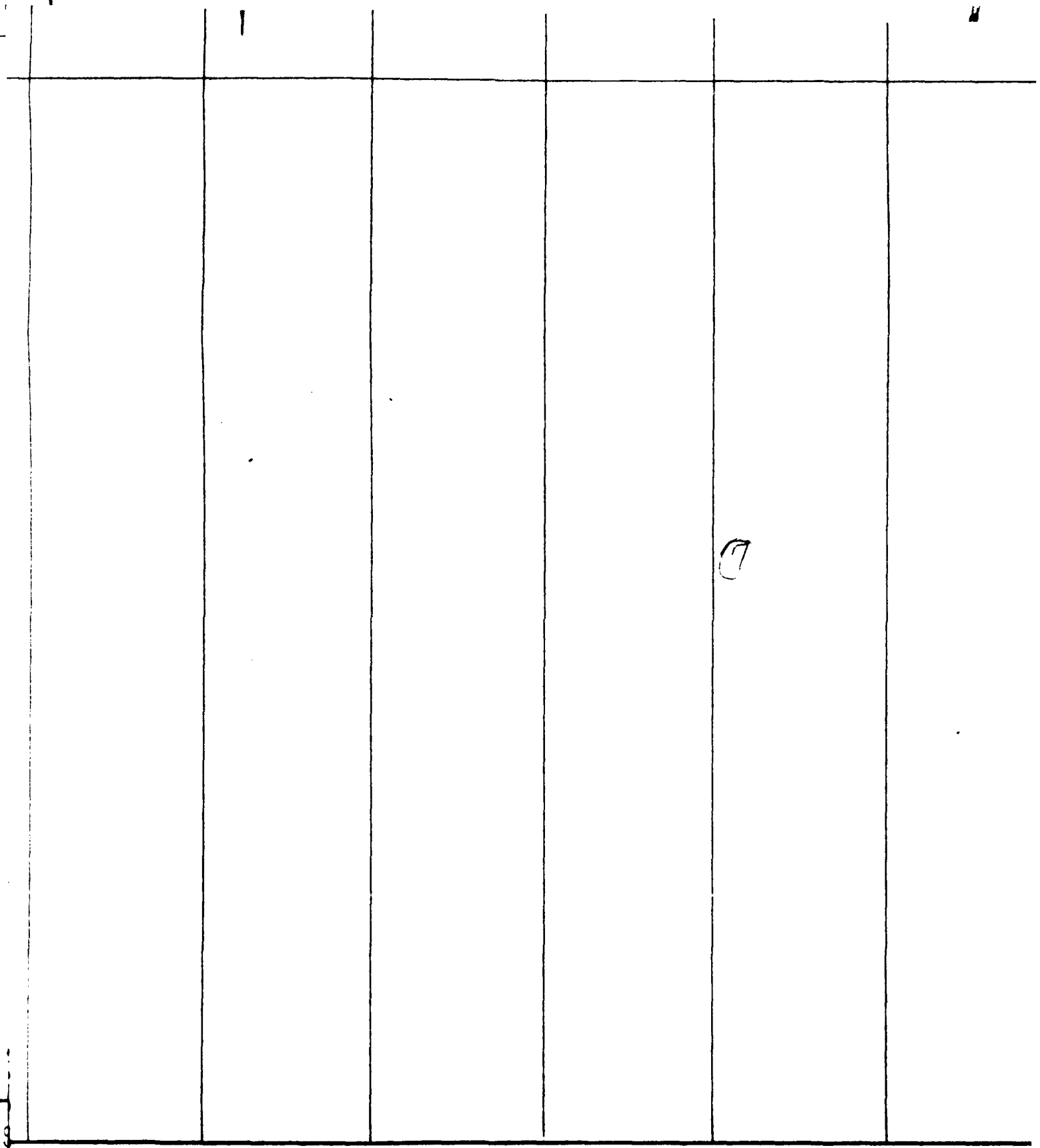
Bar Cl



nstructability Study
gent Beach Revetment
Bar Chart

Finish Core Stone From Sta [illegible]

Finish Toe Stone From Sta 333 to 176 [redacted]

Finish Toe Stone From Sta 108 to 176 [redacted]

Finish Backfill From Sta 333 to 176 [redacted]

Finish Backfilling From Sta 108 to 176 [redacted]

Restore Site [redacted]

Dismantle Temporary Facilities and Utilities [redacted]

Remove Equipment [redacted]

(8)

Sheet 2 of 2

Date	Revision	Checked	Approved

A:P3\988[illegible].002

APPENDIX O:

LOGIC REPORT

Constructability Study — PRIMAVERA PROJECT PLANNER — Sargent Beach Revetment

REPORT DATE 17AUG93 RUN NO. 17 — START DATE 1JAN95 FIN DATE 30JUN96
11:48
Logic Report Showing All Activities by Act # — DATA DATE 1JAN95 PAGE NO. 1

ACTIVITY ID	ORIG DUR	REM DUR	%	CODE	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	LATE START	LATE FINISH	TOTAL FLOAT
200	5	5	0		Prep & Submit Mooring Facility Improve. Plans	1JAN95	5JAN95	1JAN95	5JAN95	0
300	5	5	0		Prep & Submit Armor Unit Shop Drawings	1JAN95	5JAN95	1APR95	5APR95	61
400	15	15	0		Prep & Submit Precast Plant Plans	1JAN95	10JAN95	26JAN95	4FEB95	20
500	10	10	0		Prep & Submit Preliminary Schedule	1JAN95	10JAN95	30MAY96	8JUN96	515
600	40	40	0		Prep & Submit Initial Schedule	1JAN95	9FEB95	30APR96	8JUN96	485
800	5	5	0		Prep & Submit Stone Supply Submittals	1JAN95	5JAN95	3FEB95	7FEB95	23
900	15	15	0		Prep & Submit Sheet Pile Shop Drawings	1JAN95	15JAN95	9JAN95	23JAN95	6
1000	15	15	0		COE Review & Approve Mooring Fac Improve. Plans	6JAN95	20JAN95	6JAN95	20JAN95	0
1100	15	15	0		COE Review & Approve Armor Unit Shop Drawings	6JAN95	20JAN95	6APR95	20APR95	90
1200	15	15	0		COE Review & Approve Precast Plant Plans	11JAN95	25JAN95	5FEB95	19FEB95	15
1300	15	15	0		COE Review & Approve Stone Suppliers	6JAN95	20JAN95	8FEB95	22FEB95	23
1350	2	2	0		Release Purchase Orders to Stone Suppliers	21JAN95	22JAN95	23FEB95	24FEB95	23
1400	15	15	0		COE Review & Approve Sheet Pile Shop Drawings	16JAN95	30JAN95	24JAN95	7FEB95	6
1450	1	1	0		Release Purchase Orders to Sheet Pile Supplier	31JAN95	1FEB95	8FEB95	9FEB95	6
1500	5	5	0		Stage Mooring Facility Eqmt/Matls to MF2	21JAN95	25JAN95	21JAN95	25JAN95	0
1600	60	60	0		Establish Precast Plant	26JAN95	26MAR95	20FEB95	20APR95	25
1700	5	5	0		Make Improvements to Mooring Facility 2	26JAN95	30JAN95	26JAN95	30JAN95	0
1800	20	20	0		Stage Heavy Construction Equipment to MF2	31JAN95	19FEB95	31JAN95	19FEB95	0
1900	1	1	0		Redeploy Mooring Facility Eqmt to MF1	31JAN95	31JAN95	15MAR95	15MAR95	43
2000	20	20	0		Stage Blanket/Core/Toe Stone to Project Site	5FEB95	24FEB95	13APR95	2MAY95	67
2100	55	55	0		Fabricate & Stage Sheet Piles to Project Site	2FEB95	28MAR95	10FEB95	5APR95	8
2200	5	5	0		Develop Staging Area Vicinity MF2	20FEB95	24FEB95	25FEB95	1MAR95	5
2300	10	10	0		Develop Temporary Facilities & Utilities	20FEB95	1MAR95	20FEB95	1MAR95	0
2400	12	12	0		Stage Armor Units to Project Site	27MAR95	7APR95	21APR95	2MAY95	25
2500	5	5	0		Make Improvements to Mooring Facility 1	1FEB95	5FEB95	16MAR95	20MAR95	43
2600	20	20	0		Stage Haul Road Select Fill to Project Site	23JAN95	11FEB95	25FEB95	16MAR95	23
2700	15	15	0		Rough Grade Haul Road From MF2 to Vic Sta 420	2MAR95	16MAR95	2MAR95	16MAR95	0
2800	10	10	0		Stage Heavy Construction Equipment to MF1	6FEB95	15FEB95	21MAR95	30MAR95	43
2900	15	15	0		Place Geotech/Fill on Road From MF2 to Sta 420	17MAR95	31MAR95	17MAR95	31MAR95	0
3000	5	5	0		Develop Staging Area Vicinity MF1	16FEB95	20FEB95	31MAR95	4APR95	43
3100	5	5	0		Prep Site for Sheet Pile Wall Section 2	1APR95	5APR95	1APR95	5APR95	0
3200	20	20	0		Rough Grade Haul Road From MF1 to Sta 0	2MAR95	21MAR95	5APR95	24APR95	24
3300	29	29	0		Set & Drive Piles for Sheet Pile Wall Section 2	6APR95	14MAY95	6APR95	14MAY95	0
3400	20	20	0		Place Geotech/Fill on Road From MF1 to Sta 0	22MAR95	10APR95	25APR95	14MAY95	24
3450	1	1	0		Redeploy Pile Driving Eqmt/Crew to SPW Section 1	15MAY95	15MAY95	15MAY95	15MAY95	0
3500	4	4	0		Start Placing Pile Cap For SPW Sect 2	7APR95	10APR95	2MAY95	5MAY95	15
3550	1	1	0		Finish Placing Pile Cap For SPW Sect 2	15MAY95	15MAY95	15MAY95	15MAY95	0
3600	45	45	0		Construct Haul Road From MF1 to MF2	11APR95	20MAY95	11APR96	20MAY96	266
3700	11	11	0		Prep Site for Sheet Pile Wall Section 1	11APR95	26APR95	15MAY95	31JUN95	24
3800	171	171	0		Start Driving Piles for SPW Sect 1	16MAY95	2NOV95	16MAY95	2NOV95	0
3850	1	1	0		Finish Piles for SPW Sect 1	2NOV95	2NOV95	2NOV95	2NOV95	0
3900	21	21	0		Start Pile Cap for SPW Sect 1	17MAY95	6JUN95	8SEP95	28SEP95	114
3950	1	1	0		Finish Pile Cap for SPW Sect 1	4NOV95	4NOV95	4NOV95	4NOV95	0
4000	43	43	0		Start Excavating GIWW Side SPW Sect 1	18MAY95	29JUN95	9SEP95	21OCT95	114
4050	1	1	0		Finish Excavating GIWW Side SPW Sect 1	5NOV95	5NOV95	5NOV95	5NOV95	0
4100	56	56	0		Start Excavating Gulf Side SPW Sect 1	20MAY95	14JUL95	11SEP95	5NOV95	114
4150	1	1	0		Finish Excavating Gulf Side of SPW Sect 1	6NOV95	6NOV95	6NOV95	6NOV95	0

Constructability Study | PRIMAVERA PROJECT PLANNER | Sargent Beach Revetment

REPORT DATE [illegible] RUN NO. [illegible] | START DATE [illegible] FIN DATE [illegible]

[illegible] Report Showing All Activities by Act # | DATA DATE [illegible] PAGE NO. [illegible]

ACTIVITY ID	ORIG DUR	REM DUR	%	CODE	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	LATE START	LATE FINISH	TOTAL FLOAT
4200	19	19	0		Start Blanket Stone Gulf Side SPW Sect 1	[illegible]MAY95	[illegible]JUN95	[illegible]NOV95	[illegible]NOV95	[illegible]
4250	1	1	0		Finish Blanket Stone Gulf Side SPW Sect 1	7NOV95	7NOV95	[illegible]DEC95	[illegible]DEC95	[illegible]
4300	[illegible]	[illegible]	0		Start Armor Units Gulf Side SPW Sect 1	[illegible]MAY95	[illegible]JUN95	4NOV95	[illegible]DEC95	[illegible]
4350	1	1	0		Finish Armor Units Gulf Side SPW Sect 1	6NOV95	6NOV95	18DEC95	18DEC95	[illegible]
4400	[illegible]	[illegible]			Start Core Stone Gulf Side SPW Sect 1	[illegible]MAY95	[illegible]JUN95	5NOV95	[illegible]NOV95	[illegible]
4450	1	1	0		Finish Core Stone Gulf Side SPW Sect 1	9NOV95	9NOV95	19DEC95	19DEC95	[illegible]
4500	45	45	0		Start Backfill Gulf Side SPW Sect 1	24MAY95	7JUL95	6NOV95	20DEC95	166
4550	1	1	0		Finish Backfilling Gulf Side SPW Sect 1	[illegible]NOV95	[illegible]NOV95	21DEC95	21DEC95	[illegible]
4600	7	7	0		Start Blanket Stone GIWW Side SPW Sect 1	25MAY95	31MAY95	11APR96	17APR96	[illegible]
4650	1	1	0		Finish Blanket Stone GIWW Side SPW Sect 1	[illegible]NOV95	[illegible]NOV95	18APR96	18APR96	[illegible]
4700	7	7	0		Start Core Stone GIWW Side SPW Sect 1	26MAY95	[illegible]JUN95	12APR96	18APR96	[illegible]
4750	1	1	0		Finish Core Stone GIWW Side SPW Sect 1	12NOV95	12NOV95	19APR96	19APR96	159
4800	[illegible]	[illegible]	0		Start Excavating GIWW Side of SPW Sect 2	3APR95	16APR95	3MAY95	[illegible]MAY95	[illegible]
4850	1	1	0		Finish Excavating GIWW Side of SPW Sect 2	16MAY95	16MAY95	16MAY95	16MAY95	[illegible]
4900	12	12	0		Start Excavating Gulf Side of SPW Sect 2	10APR95	21APR95	5MAY95	16MAY95	25
4950	1	1	0		Finish Excavating Gulf Side of SPW Sect 2	17MAY95	17MAY95	17MAY95	17MAY95	0
5000	4	4	0		Start Blanket Stone on Gulf Side SPW Sect 2	11APR95	14APR95	23JUL95	26JUL95	103
5050	1	1	0		Finish Blanket Stone on Gulf Side SPW Sect 2	18MAY95	18MAY95	1AUG95	1AUG95	75
5100	7	7	0		Start Placing Armor Units Gulf Side SPW Sect 2	12APR95	18APR95	24JUL95	30JUL95	103
5150	1	1	0		Finish Armor Units on Gulf Side of SPW Sect 2	19MAY95	19MAY95	2AUG95	2AUG95	75
5200	2	2	0		Start Placing Core Stone Gulf Side SPW Sect 2	13APR95	14APR95	25JUL95	26JUL95	103
5250	1	1	0		Finish Core Stone on Gulf Side of SPW Sect 2	20MAY95	20MAY95	3AUG95	3AUG95	75
5300	10	10	0		Start Backfilling Gulf Side SPW Sect 2	14APR95	23APR95	26JUL95	4AUG95	103
5350	1	1	0		Finish Backfilling Gulf Side of SPW Sect 2	21MAY95	21MAY95	5AUG95	5AUG95	76
5400	1	1	0		Start Blanket Stone GIWW Side of SPW Sect 2	15APR95	15APR95	27APR96	27APR96	378
5450	1	1	0		Finish Blanket Stone on GIWW Side of SPW Sect 2	22MAY95	22MAY95	28APR96	28APR96	342
5500	1	1	0		Start Core Stone on GIWW Side of SPW Sect 2	16APR95	16APR95	28APR96	28APR96	378
5550	1	1	0		Finish Core Stone on GIWW Side of SPW Sect 2	23MAY95	23MAY95	29APR96	29APR96	342
5600	69	69	0		Excavate/Dewater From Sta 340+80 to Sta 368+50	18MAY95	25JUL95	18MAY95	25JUL95	0
5700	21	21	0		Start Fill From Sta 340+80 to 368+50	19MAY95	8JUN95	31JUL95	20AUG95	[illegible]
5750	1	1	0		Finish Fill From Sta 340+80 to 368+50	26JUL95	26JUL95	23SEP95	23SEP95	59
5800	4	4	0		Start Geotextile From Sta 340+80 to 368+50	20MAY95	23MAY95	1AUG95	4AUG95	[illegible]
5850	1	1	0		Finish Geotextile From Sta 340+80 to 368+50	27JUL95	27JUL95	24SEP95	24SEP95	59
5900	13	13	0		Start Blanket Stone From Sta 340+80 to 368+50	21MAY95	2JUN95	2AUG95	14AUG95	[illegible]
5950	1	1	0		Finish Blanket Stone From Sta 340+80 to 368+50	28JUL95	28JUL95	25SEP95	25SEP95	59
6000	45	45	0		Start Armor Units From Sta 340+80 to 368+50	22MAY95	5JUL95	3AUG95	16SEP95	[illegible]
6050	1	1	0		Finish Armor Units From Sta 340+80 to 368+50	29JUL95	29JUL95	26SEP95	26SEP95	59
6100	5	5	0		Start Core Stone From Sta 340+80 to 368+50	23MAY95	27MAY95	4AUG95	8AUG95	[illegible]
6150	1	1	0		Finish Core Stone From Sta 340+80 to 368+50	30JUL95	30JUL95	27SEP95	27SEP95	59
6200	[illegible]	[illegible]	0		Start Toe Stone From Sta 340+80 to 368+50	24MAY95	[illegible]JUN95	5AUG95	15AUG95	[illegible]
6250	1	1			Finish Toe Stone From Sta 340+80 to 368+50	31JUL95	31JUL95	28SEP95	28SEP95	59
6300	54	54			Start Backfilling From Sta 340+80 to 368+50	25MAY95	17JUL95	6AUG95	28SEP95	[illegible]
6350	1	1			Finish Backfill From Sta 340+80 to 368+50	1AUG95	1AUG95	29SEP95	29SEP95	59
[illegible]	[illegible]	[illegible]			Excavate Typ 1:2.5 Sect From Sta 78+60 to 0+00	7NOV95	10FEB96	7NOV95	10FEB96	
6500	[illegible]	[illegible]			Start Geotextile From Sta 78+60 to 0+00	3NOV95	16NOV95	17DEC95	30DEC95	[illegible]
6550	1	1			Finish Geotextile From Sta 78+60 to 0+00	11FEB96	11FEB96	2MAR96	2MAR96	[illegible]
6600	21	21			Start Blanket Stone From Sta 78+60 to 0+00	9NOV95	29NOV95	18DEC95	7JAN96	[illegible]

Interstate Study — PRIMAVERA PROJECT PLANNER — Short Crest Reinforcement

REPORT DATE 12AUG97 — RUN NO. 17 — START DATE 1-JAN95 — FIN DATE 31JAN96
10:40

Logic Report Showing All Activities by Act #

DATA DATE 1-JAN95 — PAGE NO. 1

ACTIVITY ID	ORIG DUR	REM DUR	%	CODE	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	LATE START	LATE FINISH	TOTAL FLOAT
a650	1	1	0		Finish Blanket Stone From Sta 78+60 to 0+00	12FEB96	12FEB96	7MAR96	7MAR96	20
a700	39	39	0		Start Armor Units From Sta 78+60 to 0+00	13NOV95	17JAN96	18DEC95	25FEB96	29
a750	1	1	0		Finish Armor Units From Sta 78+60 to 0+00	12FEB96	12FEB96	4MAR96	4MAR96	20
a800	5	5	0		Start Core Stone From Sta 78+60 to 0+00	13NOV95	19NOV95	24DEC95	29DEC95	29
a850	1	1	0		Finish Core Stone From Sta 78+60 to 0+00	14FEB96	14FEB96	5MAR96	5MAR96	20
a900	19	19	0		Start Toe Stone From Sta 78+60 to 0+00	22NOV95	20NOV95	21DEC95	8JAN96	29
a950	1	1	0		Finish Toe Stone From Sta 78+60 to 0+00	15FEB96	15FEB96	6MAR96	6MAR96	20
b000	76	76	0		Start Backfilling From Sta 78+60 to 0+00	13NOV95	27JAN96	22DEC95	6MAR96	29
b050	0	0	0		Finish Backfilling From Sta 78+60 to 0+00	16FEB96	16FEB96	7MAR96	7MAR96	20
b100	68	68	0		Excavate Typ 1:2.5 Sect Fr Sta 368+50 to 419+92	26JUL95	10OCT95	26JUL95	10OCT95	0
b200	0	0	0		Start Geotextile From Sta 368+50 to 419+92	26JUL95	24AUG95	25SEP95	30SEP95	59
b250	1	1	0		Finish Geotextile From Sta 368+50 to 419+92	10OCT95	10OCT95	17NOV95	17NOV95	46
b300	15	15	0		Start Blanket Stone From Sta 368+50 to 419+92	29JUL95	12AUG95	26SEP95	10OCT95	59
b350	1	1	0		Finish Blanket Stone From Sta 368+50 to 419+92	10OCT95	10OCT95	18NOV95	18NOV95	46
b400	49	49	0		Start Armor Units From Sta 368+50 to 419+92	20JUL95	16SEP95	27SEP95	14NOV95	59
b450	1	1	0		Finish Armor Units From Sta 368+50 to 419+92	40CT95	40CT95	19NOV95	19NOV95	46
b500	0	0	0		Start Core Stone From Sta 368+50 to 419+92	31JUL95	5AUG95	28SEP95	30CT95	59
b550	1	1	0		Finish Core Stone From Sta 368+50 to 419+92	50CT95	50CT95	20NOV95	20NOV95	46
b600	12	12	0		Start Toe Stone From Sta 368+50 to 419+92	1AUG95	13AUG95	29SEP95	11OCT95	59
b650	1	1	0		Finish Toe Stone From Sta 368+50 to 419+92	60CT95	60CT95	21NOV95	21NOV95	46
b700	52	52	0		Start Backfilling Fr Sta 368+50 to 419+92	2AUG95	23SEP95	30SEP95	21NOV95	59
b750	1	1	0		Finish Backfilling From Sta 368+50 to 419+92	70CT95	70CT95	22NOV95	22NOV95	46
b800	222	222	0		Excavate Typ 1:2.5 Sect From Sta 333 to 176	20CT95	20MAY96	20CT95	20MAY96	0
b900	21	21	0		Start Geotextile From Sta 333 to 176	20CT95	23OCT95	18NOV95	8DEC95	46
b950	1	1	0		Finish Geotextile From Sta 333 to 176	21MAY96	21MAY96	21MAY96	21MAY96	0
c000	49	49	0		Start Blanket Stone From Sta 333 to 176	40CT95	21NOV95	19NOV95	6JAN96	46
c050	1	1	0		Finish Blanket Stone From Sta 333 to 176	22MAY96	22MAY96	22MAY96	22MAY96	0
c100	171	171	0		Start Armor Units From Sta 333 to 176	50CT95	23MAR96	20NOV95	8MAY96	46
c150	1	1	0		Finish Armor Units From Sta 333 to 176	23MAY96	23MAY96	23MAY96	23MAY96	0
c200	33	33	0		Start Core Stone From Sta 333 to 176	60CT95	28OCT95	21NOV95	13DEC95	46
c250	1	1	0		Finish Core Stone From Sta 333 to 176	24MAY96	24MAY96	24MAY96	24MAY96	0
c300	47	47	0		Start Toe Stone From Sta 333 to 176	70CT95	22NOV95	22NOV95	7JAN96	46
c350	1	1	0		Finish Toe Stone From Sta 333 to 176	25MAY96	25MAY96	25MAY96	25MAY96	0
c400	185	185	0		Start Backfilling From Sta 333 to 176	80CT95	9APR96	23NOV95	25MAY96	46
c450	1	1	0		Finish Backfill From Sta 333 to 176	26MAY96	26MAY96	26MAY96	26MAY96	0
c500	190	190	0		Excavate Typ 1:2.5 Sect From Sta 108 to 176	11FEB96	20MAY96	11FEB96	20MAY96	0
c600	5	5	0		Start Geotextile From Sta 108 to 176	12FEB96	20FEB96	7MAR96	11MAR96	20
c650	1	1	0		Finish Geotextile From Sta 108 to 176	21MAY96	21MAY96	21MAY96	21MAY96	0
c700	21	21	0		Start Blanket Stone From Sta 108 to 176	12FEB96	4MAR96	4MAR96	24MAR96	20
c750	1	1	0		Finish Blanket Stone From Sta 108 to 176	22MAY96	22MAY96	22MAY96	22MAY96	0
c800	77	77	0		Start Armor Units From Sta 108 to 176	14FEB96	26APR96	5MAR96	16MAY96	20
c850	1	1	0		Finish Armor Units From Sta 108 to 176	23MAY96	23MAY96	23MAY96	23MAY96	0
c900	8	8	0		Start Core Stone From Sta 108 to 176	15FEB96	22FEB96	6MAR96	14MAR96	20
c950	1	1	0		Finish Core Stone From Sta 108 to 176	24MAY96	24MAY96	24MAY96	24MAY96	0
d000	19	19	0		Start Toe Stone From Sta 108 to 176	16FEB96	5MAR96	7MAR96	25MAR96	20
d050	1	1	0		Finish Toe Stone From Sta 108 to 176	25MAY96	25MAY96	25MAY96	25MAY96	0
d100	73	73	0		Start Backfilling From Sta 108 to 176	17FEB96	5MAY96	8MAR96	25MAY96	20

Constructability Study — PRIMAVERA PROJECT PLANNER — Sargent Beach Revetment

REPORT DATE 12AUG95 RUN NO. 17 — START DATE 1JAN95 FIN DATE 8JUN96
11:46

Basic Report Showing All Activities by Act #

DATA DATE 1JAN95 PAGE NO. 4

ACTIVITY ID	ORIG DUR	REM DUR	%	CODE	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	LATE START	LATE FINISH	TOTAL FLOAT
9150	1	1	0		Finish Backfilling From Sta 108 to 17o	26MAY96	26MAY96	26MAY96	26MAY96	0
9200	40	40	0		Landscape From Sta 108 to Sta 0	17FEB96	27MAR96	20APR96	29MAY96	63
9300	30	30	0		Landscape From Sta 333 to Sta 419+92	8OCT95	6NOV95	30APR96	29MAY96	205
9400	90	90	0		Landscape From Sta 108 to Sta 333	1MAR96	29MAY96	1MAR96	29MAY96	0
9500	5	5	0		Restore Site	30MAY96	3JUN96	30MAY96	3JUN96	0
9600	5	5	0		Dismantle Temporary Facilities and Utilities	30MAY96	3JUN96	30MAY96	3JUN96	0
9700	5	5	0		Remove Equipment	4JUN96	8JUN96	4JUN96	8JUN96	0

APPENDIX P:

CRITICALITY REPORT

Constructability Study — PRIMAVERA PROJECT PLANNER — Earliest Start-November

REPORT DATE 13AUG97 RUN NO. 19 — START DATE 01JAN95 FIN DATE 21JAN96
12:06

Criticality Report, Sorted by TF and ES — DATA DATE 01JAN95 PAGE NO. 1

ACTIVITY ID	ORIG DUR	REM DUR	%	CODE	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	LATE START	LATE FINISH	TOTAL FLOAT
100	5	5	0		Prep & Submit Mooring Facility Improv. Plans	01JAN95	05JAN95	01JAN95	05JAN95	0
1000	15	15	0		COE Review & Approve Mooring Fac Improv. Plans	06JAN95	20JAN95	06JAN95	20JAN95	0
1500	5	5	0		Stage Mooring Facility Eqmt/Matls to MF2	21JAN95	25JAN95	21JAN95	25JAN95	0
1700	5	5	0		Make Improvements to Mooring Facility 2	26JAN95	30JAN95	26JAN95	30JAN95	0
1800	20	20	0		Stage Heavy Construction Equipment to MF2	01JAN95	19FEB95	01JAN95	19FEB95	0
2000	10	10	0		Develop Temporary Facilities & Utilities	20FEB95	1MAR95	20FEB95	1MAR95	0
2700	15	15	0		Rough Grade Haul Road From MF2 to Vic Sta 420	2MAR95	16MAR95	2MAR95	16MAR95	0
2900	15	15	0		Place Geotech/Fill on Road From MF2 to Sta 420	17MAR95	31MAR95	17MAR95	31MAR95	0
3100	5	5	0		Prep Site for Sheet Pile Wall Section 2	1APR95	5APR95	1APR95	5APR95	0
3300	29	29	0		Set & Drive Piles for Sheet Pile Wall Section 2	6APR95	14MAY95	6APR95	14MAY95	0
3450	1	1	0		Redeploy Pile Driving Eqmt/Crew to SPW Section 1	15MAY95	15MAY95	15MAY95	15MAY95	0
3550	1	1	0		Finish Placing Pile Cap for SPW Sect 2	15MAY95	15MAY95	15MAY95	15MAY95	0
3800	171	171	0		Start Driving Piles for SPW Sect 1	16MAY95	2NOV95	16MAY95	2NOV95	0
4850	1	1	0		Finish Excavating GIWW Side of SPW Sect 2	16MAY95	16MAY95	16MAY95	16MAY95	0
4950	1	1	0		Finish Excavating Gulf Side of SPW Sect 2	17MAY95	17MAY95	17MAY95	17MAY95	0
5600	69	69	0		Excavate/Dewater From Sta 340+80 to Sta 368+50	18MAY95	25JUL95	18MAY95	25JUL95	1
7100	68	68	0		Excavate Typ 1:2.5 Sect Fr Sta 368+50 to 419+92	26JUL95	10CT95	26JUL95	10CT95	0
7800	232	232	0		Excavate Typ 1:2.5 Sect From Sta 333 to 176	20CT95	20MAY96	20CT95	20MAY96	0
3850	1	1	0		Finish Piles for SPW Sect 1	3NOV95	3NOV95	3NOV95	3NOV95	0
3950	1	1	0		Finish Pile Cap for SPW Sect 1	4NOV95	4NOV95	4NOV95	4NOV95	0
4050	1	1	0		Finish Excavating GIWW Side SPW Sect 1	5NOV95	5NOV95	5NOV95	5NOV95	0
4150	1	1	0		Finish Excavating Gulf Side of SPW Sect 1	6NOV95	6NOV95	6NOV95	6NOV95	0
8400	96	96	0		Excavate Typ 1:2.5 Sect From Sta 78+60 to 0+00	7NOV95	10FEB96	7NOV95	10FEB96	0
8500	100	100	0		Excavate Typ 1:2.5 Sect From Sta 108 to 176	11FEB96	20MAY96	11FEB96	20MAY96	0
9400	90	90	0		Landscape From Sta 108 to Sta 333	1MAR96	29MAY96	1MAR96	29MAY96	0
7950	1	1	0		Finish Geotextile From Sta 333 to 176	21MAY96	21MAY96	21MAY96	21MAY96	0
8650	1	1	0		Finish Geotextile From Sta 108 to 176	21MAY96	21MAY96	21MAY96	21MAY96	0
8050	1	1	0		Finish Blanket Stone From Sta 333 to 176	22MAY96	22MAY96	22MAY96	22MAY96	0
8750	1	1	0		Finish Blanket Stone From Sta 108 to 176	22MAY96	22MAY96	22MAY96	22MAY96	0
8150	1	1	0		Finish Armor Units From Sta 333 to 176	23MAY96	23MAY96	23MAY96	23MAY96	0
8850	1	1	0		Finish Armor Units From Sta 108 to 176	23MAY96	23MAY96	23MAY96	23MAY96	0
9250	1	1	0		Finish Core Stone From Sta 333 to 176	24MAY96	24MAY96	24MAY96	24MAY96	0
8950	1	1	0		Finish Core Stone From Sta 108 to 176	24MAY96	24MAY96	24MAY96	24MAY96	0
8350	1	1	0		Finish Toe Stone From Sta 333 to 176	25MAY96	25MAY96	25MAY96	25MAY96	0
9050	1	1	0		Finish Toe Stone From Sta 108 to 176	25MAY96	25MAY96	25MAY96	25MAY96	0
8450	1	1	0		Finish Backfill From Sta 333 to 176	26MAY96	26MAY96	26MAY96	26MAY96	0
9150	1	1	0		Finish Backfilling From Sta 108 to 176	26MAY96	26MAY96	26MAY96	26MAY96	0
9500	5	5	0		Restore Site	30MAY96	03JUN96	30MAY96	03JUN96	0
9600	5	5	0		Dismantle Temporary Facilities and Utilities	30MAY96	03JUN96	30MAY96	03JUN96	0
9700	5	5	0		Remove Equipment	4JUN96	8JUN96	4JUN96	8JUN96	0
2200	5	5	0		Develop Staging Area Vicinity MF2	20FEB95	24FEB95	25FEB95	1MAR95	5
900	15	15	0		Prep & Submit Sheet Pile Shop Drawings	1JAN95	15JAN95	9JAN95	23JAN95	8
1400	15	15	0		COE Review & Approve Sheet Pile Shop Drawings	16JAN95	30JAN95	24JAN95	7FEB95	6
1450	1	1	0		Release Purchase Orders to Sheet Pile Supplier	31JAN95	1FEB95	8FEB95	9FEB95	6
2100	55	55	0		Fabricate & Stage Sheet Piles to Project Site	2FEB95	29MAR95	10FEB95	5APR95	6
8550	1	1	0		Finish Geotextile From Sta 78+60 to 0+00	11FEB96	11FEB96	2MAR96	2MAR96	20
8650	1	1	0		Finish Blanket Stone From Sta 78+60 to 0+00	12FEB96	12FEB96	3MAR96	3MAR96	20

Intercoastal Stud. PRIMAVERA PROJECT PLANNER Barbers Beach Revetment

REPORT DATE 13AUG95 RUN NO. 18
12:56

Activity Report, Sorted by TF and ES DATA DATE 1JAN95 PAGE NO. 1

ACTIVITY ID	ORIG DUR	REM DUR	%	CODE	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	LATE START	LATE FINISH	TOTAL FLOAT
3600	3	3	0		Start Geotextile From Sta 108 to 176	13FEB96	15FEB96	2MAR96	6MAR96	15
3750	0	0			Finish Armor Units From Sta 78+60 to 0+00	13FEB96	13FEB96	4MAR96	4MAR96	15
3700	20	20			Start Blanket Stone From Sta 108 to 176	13FEB96	4MAR96	4MAR96	24MAR96	15
3850	0	0	0		Finish Core Stone From Sta 78+60 to 0+00	14FEB96	14FEB96	5MAR96	5MAR96	20
3800	77	77	0		Start Armor Units From Sta 108 to 176	14FEB96	26APR96	5MAR96	16MAY96	15
3750	0	0	0		Finish Toe Stone From Sta 78+60 to 0+00	15FEB96	15FEB96	6MAR96	6MAR96	15
3900	3	3	0		Start Core Stone From Sta 108 to 176	15FEB96	17FEB96	6MAR96	14MAR96	20
7050	0	0	0		Finish Backfilling From Sta 78+60 to 0+00	16FEB96	16FEB96	7MAR96	7MAR96	15
9000	19	19	0		Start Toe Stone From Sta 108 to 176	16FEB96	5MAR96	7MAR96	25MAR96	15
9100	79	79	0		Start Backfilling From Sta 108 to 176	17FEB96	5MAY96	8MAR96	25MAY96	15
400	10	10	0		Prep & Submit Precast Plant Plans	1JAN95	10JAN95	26JAN95	4FEB95	25
1200	15	15	0		COE Review & Approve Precast Plant Plans	11JAN95	25JAN95	5FEB95	19FEB95	25
1600	60	60	0		Establish Precast Plant	26JAN95	26MAR95	20FEB95	20APR95	25
2400	12	12	0		Stage Armor Units to Project Site	27MAR95	7APR95	21APR95	2MAY95	25
3500	4	4	0		Start Placing File Cap For SPW Sect 2	7APR95	10APR95	2MAY95	5MAY95	25
4800	9	9	0		Start Excavating GIWW Side of SPW Sect 2	8APR95	16APR95	3MAY95	11MAY95	25
4900	12	12	0		Start Excavating Gulf Side of SPW Sect 2	10APR95	21APR95	5MAY95	16MAY95	25
800	5	5	0		Prep & Submit Stone Supply Submittals	1JAN95	5JAN95	3FEB95	7FEB95	23
1300	15	15	0		COE Review & Approve Stone Suppliers	6JAN95	20JAN95	8FEB95	22FEB95	23
1350	2	2	0		Release Purchase Orders to Stone Suppliers	21JAN95	22JAN95	23FEB95	24FEB95	23
2600	20	20	0		Stage Haul Road Select Fill to Project Site	23JAN95	11FEB95	25FEB95	16MAR95	23
3200	20	20	0		Rough Grade Haul Road From MF1 to Sta 0	2MAR95	21MAR95	5APR95	24APR95	24
3400	20	20	0		Place Geotech/Fill on Road From MF1 to Sta 0	22MAR95	10APR95	25APR95	14MAY95	24
3700	20	20	0		Prep Site for Sheet Pile wall Section 1	11APR95	30APR95	15MAY95	31JUN95	24
6500	9	9	0		Start Geotextile From Sta 78+60 to 0+00	8NOV95	16NOV95	17DEC95	25DEC95	29
6600	21	21	0		Start Blanket Stone From Sta 78+60 to 0+00	9NOV95	29NOV95	18DEC95	7JAN96	29
6700	69	69	0		Start Armor Units From Sta 78+60 to 0+00	10NOV95	17JAN96	19DEC95	25FEB96	29
6800	9	9	0		Start Core Stone From Sta 78+60 to 0+00	11NOV95	19NOV95	20DEC95	28DEC95	29
6900	19	19	0		Start Toe Stone From Sta 78+60 to 0+00	12NOV95	30NOV95	21DEC95	8JAN96	29
7000	76	76	0		Start Backfilling From Sta 78+60 to 0+00	13NOV95	27JAN96	22DEC95	6MAR96	29
4250	1	1	0		Finish Blanket Stone Gulf Side SPW Sect 1	7NOV95	7NOV95	17DEC95	17DEC95	40
4350	1	1	0		Finish Armor Units Gulf Side SPW Sect 1	8NOV95	8NOV95	18DEC95	18DEC95	40
4450	1	1	0		Finish Core Stone Gulf Side SPW Sect 1	9NOV95	9NOV95	19DEC95	19DEC95	40
4550	1	1	0		Finish Backfilling Gulf Side SPW Sect 1	10NOV95	10NOV95	21DEC95	21DEC95	41
1900	1	1	0		Redeploy Mooring Facility East to MF1	31JAN95	31JAN95	15MAR95	15MAR95	42
2500	5	5	0		Make Improvements to Mooring Facility 1	1FEB95	5FEB95	16MAR95	20MAR95	43
2800	10	10	0		Stage Heavy Construction Equipment to MF1	6FEB95	15FEB95	21MAR95	30MAR95	42
3100	5	5	0		Develop Staging Area Vicinity MF1	16FEB95	20FEB95	31MAR95	4APR95	42
7250	1	1	0		Finish Geotextile From Sta 368+50 to 419+92	20CT95	20CT95	17NOV95	17NOV95	46
7750	1	1	0		Finish Blanket Stone From Sta 368+50 to 419+92	30CT95	30CT95	18NOV95	18NOV95	46
7700	21	21	0		Start Geotextile From Sta 333 to 176	20CT95	230CT95	19NOV95	8DEC95	46
7450	0	0	0		Finish Armor Units From Sta 368+50 to 419+92	40CT95	40CT95	19NOV95	19NOV95	46
8000	49	49	0		Start Blanket Stone From Sta 333 to 176	40CT95	21NOV95	19NOV95	6JAN96	46
7550	1	1	0		Finish Core Stone From Sta 368+50 to 419+92	50CT95	50CT95	20NOV95	20NOV95	46
8100	171	171	0		Start Armor units From Sta 333 to 176	50CT95	23MAR96	20NOV95	8MAY96	46
7650	1	1	0		Finish Toe Stone From Sta 368+50 to 419+92	60CT95	60CT95	21NOV95	21NOV95	46
8200	20	20	0		Start Core Stone From Sta 333 to 176	60CT95	280CT95	21NOV95	13DEC95	46

ACTIVITY ID	ORIG DUR	REM DUR			ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	LATE START	LATE FINISH	TOTAL FLOAT
A750	1	1			Finish Backfilling From Sta 368+50 to 419+92	22*95	22OCT95	22NOV95	22NOV95	46
B200	47	47			Start Toe Stone From Sta 222 to 176	22OCT95	22NOV95	22NOV95	7JAN96	46
B400	135	135			Start Backfilling From Sta 222 to 176	22OCT95	24APR96	22NOV95	25MAY96	46
B750	1	1			Finish Fill From Sta 340+80 to 368+50	26JUL95	26JUL95	25SEP95	25SEP95	59
B850	1	1			Finish Geotextile From Sta 340+80 to 368+50	27JUL95	27JUL95	26SEP95	26SEP95	59
B950	1	1			Finish Blanket Stone From Sta 340+80 to 368+50	28JUL95	28JUL95	27SEP95	27SEP95	59
C200	5	5			Start Geotextile From Sta 368+50 to 419+92	28JUL95	2AUG95	28SEP95	30SEP95	59
C450	1	1			Finish Armor Units From Sta 340+80 to 368+50	28JUL95	28JUL95	28SEP95	28SEP95	59
C500	15	15			Start Blanket Stone From Sta 368+50 to 419+92	28JUL95	12AUG95	28SEP95	16OCT95	59
C650	1	1			Finish Core Stone From Sta 340+80 to 368+50	30JUL95	30JUL95	29SEP95	29SEP95	59
C700	43	43			Start Armor Units From Sta 368+50 to 419+92	30JUL95	26SEP95	29SEP95	14NOV95	59
C850	1	1			Finish Toe Stone From Sta 340+80 to 368+50	31JUL95	31JUL95	28SEP95	28SEP95	59
C900	5	5			Start Core Stone From Sta 368+50 to 419+92	31JUL95	5AUG95	28SEP95	3OCT95	59
D050	1	1			Finish Backfill From Sta 340+80 to 368+50	1AUG95	1AUG95	29SEP95	29SEP95	59
D200	12	12			Start Toe Stone From Sta 368+50 to 419+92	1AUG95	13AUG95	29SEP95	11OCT95	59
D700	83	83			Start Backfilling Fr Sta 368+50 to 419+92	2AUG95	23SEP95	30SEP95	21NOV95	59
D900	40	40			Landscape From Sta 108 to Sta 0	17FEB96	27MAR96	20APR96	29MAY96	63
E000	20	20			Stage Blanket/Core/Toe Stone to Project Site	5FEB95	24FEB95	13APR95	2MAY95	67
E700	21	21			Start Fill From Sta 340+80 to 368+50	19MAY95	6JUN95	31JUL95	20AUG95	73
E800	4	4			Start Geotextile From Sta 340+80 to 368+50	20MAY95	23MAY95	1AUG95	4AUG95	73
E900	12	12			Start Blanket Stone From Sta 340+80 to 368+50	21MAY95	2JUN95	2AUG95	14AUG95	73
F000	45	45			Start Armor Units From Sta 340+80 to 368+50	22MAY95	5JUL95	3AUG95	16SEP95	73
F100	5	5			Start Core Stone From Sta 340+80 to 368+50	22MAY95	27MAY95	4AUG95	8AUG95	72
F200	11	11			Start Toe Stone From Sta 340+80 to 368+50	24MAY95	7JUN95	5AUG95	15AUG95	73
F300	84	84			Start Backfilling From Sta 340+80 to 368+50	25MAY95	17JUL95	6AUG95	28SEP95	73
F450	1	1			Finish Blanket Stone on Gulf Side SPM Sect 2	18MAY95	18MAY95	1AUG95	1AUG95	75
F550	1	1			Finish Armor Units on Gulf Side of SPM Sect 2	19MAY95	19MAY95	2AUG95	2AUG95	75
F650	1	1			Finish Core Stone on Gulf Side of SPM Sect 2	20MAY95	20MAY95	3AUG95	3AUG95	75
F750	1	1			Finish Backfilling Gulf Side of SPM Sect 2	21MAY95	21MAY95	5AUG95	5AUG95	76
F800	5	5			Prep & Submit Armor Unit Shop Drawings	1JAN95	5JAN95	1APR95	5APR95	90
F900	15	15			COE Review & Approve Armor Unit Shop Drawings	6JAN95	20JAN95	6APR95	20APR95	90
G000	4	4			Start Blanket Stone on Gulf Side SPM Sect 2	11APR95	14APR95	23JUL95	26JUL95	103
G100	1	1			Start Placing Armor Units Gulf Side SPM Sect 2	12APR95	13APR95	24JUL95	30JUL95	103
G200	2	2			Start Placing Core Stone Gulf Side SPM Sect 2	12APR95	14APR95	25JUL95	26JUL95	103
G250	1	1			Start Backfilling Gulf Side SPM Sect 2	14APR95	22APR95	26JUL95	4AUG95	103
G300	21	21			Start Pile Cap for SPM Sect 1	17MAY95	6JUN95	8SEP95	28SEP95	114
G400	47	47			Start Excavating GIWW Side SPM Sect 1	16MAY95	29JUN95	9SEP95	21OCT95	114
G500	26	26			Start Excavating Gulf Side SPM Sect 1	17MAY95	14JUL95	11SEP95	5NOV95	114
G650	1	1			Finish Blanket Stone GIWW Side SPM Sect 1	11NOV95	11NOV95	18APR96	18APR96	159
G750	1	1			Finish Core Stone GIWW Side SPM Sect 1	12NOV95	12NOV95	19APR96	19APR96	159
G800	19	19			Start Blanket Stone Gulf Side SPM Sect 1	21MAY95	8JUN95	7NOV95	21NOV95	156
G900	72	72			Start Armor Units Gulf Side SPM Sect 1	22MAY95	22JUN95	4NOV95	5DEC95	166
H000	11	11			Start Core Stone Gulf Side SPM Sect 1	22MAY95	23JUN95	5NOV95	15NOV95	166
H050	45	45			Start Backfill Gulf Side SPM Sect 1	24MAY95	27JUL95	6NOV95	20DEC95	166
H200	21	21			Landscape From Sta 333 to Sta 419+92	30OCT95	6NOV95	30APR96	29MAY96	205
H400	1	1			Start Blanket Stone GIWW Side SPM Sect 1	15MAY95	21MAY95	11APR96	17APR96	222
H700	1	1			Start Core Stone GIWW Side SPM Sect 1	15MAY95	12JUN95	12APR96	18APR96	222

Constructability Study — PRIMAVERA PROJECT PLANNER — Sargent Beach Revetment

REPORT DATE 12AUG93 RUN NO. 19 — START DATE 01JAN95 FIN DATE 01JUN96
12:06

Constructability Report, Sorted by TF and ES — DATA DATE 01JAN95 PAGE NO. 4

ACTIVITY ID	ORIG DUR	REM DUR	%	CODE	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	LATE START	LATE FINISH	TOTAL FLOAT
5450	1	1	0		Finish Blanket Stone on GIWW Side of SPW Sect 2	22MAY95	22MAY95	28APR96	29APR96	342
5550	1	1	0		Finish Core Stone on GIWW Side of SPW Sect 2	22MAY95	22MAY95	29APR96	29APR96	342
3600	40	40	0		Construct Haul Road From MF1 to MF2	11APR95	20MAY95	11APR96	20MAY96	366
5400	1	1	0		Start Blanket Stone GIWW Side of SPW Sect 2	15APR95	15APR95	27APR96	27APR96	378
5500	1	1	0		Start Core Stone on GIWW Side of SPW Sect 2	16APR95	16APR95	28APR96	28APR96	378
500	40	40	0		Prep & Submit Initial Schedule	1JAN95	9FEB95	30APR96	8JUN96	485
500	10	10	0		Prep & Submit Preliminary Schedule	1JAN95	10JAN95	30MAY96	8JUN96	515

APPENDIX Q:

SUMMARY OF RESPONSES TO CONSTRUCTABILITY SYMPOSIUM FOLLOW-UP QUESTIONNAIRE

CONSTRUCTABILITY SYMPOSIUM

QUESTIONNAIRE RESPONSES

4/1/93

1. What was the primary reason you attended the Sargent Beach constructability symposium?

   ___ To learn more about the project from a business development standpoint. **(7)**

   ___ To attempt to influence the design of the project as a result of my experience in this type of work. **(4)**

   ___ As a personal favor to Chuck McGinnis.

   ___ Because CII sponsored it. **(2)**

   ___ Other (Please Describe) _____
   To learn first hand some of the design concepts being considered

2. How much would you estimate your attendance cost your firm, in terms of airfare, the cost of your time, etc.?

   $2,000 (2); $1,500 (3); $1,475; $1,070; $1,000; $875; $450; $250

3. What did you expect to get from the symposium?

   - An understanding of how the project was designed and the parameters used in developing the design. Then being able and capable of looking at the aspects of modifying the design and the execution plan it optimizes cost, schedule and life cycle of improvement.
   - I had no idea what to expect.
   - Project information.
   - A better understanding of project and different views of other contractors on the work.
   - Project information and the opportunity to influence design.
   - Discussions on design/construction problems.

- o A better understanding of the design aspects of the project from the owner's perspective, plus the opportunity to provide input into the design from the contractor's viewpoint.

- o Unsure as this was a first; as a minimum to gain better understanding of process and specifics of project.

- o Knowledge of the specific project and the opportunity to provide input and make the project more constructable.

- o To hear the most current plans, design and time frame for the project. To receive some flavor for the U.S. Corps of Engineers total plan for the project; i.e. one or more contracts.

- o Lead on potential work.

- o An understanding of the project; interaction with CII; constructability experience; and meeting other contractors.

4. What did you actually get from it?

- o An understanding of the project, its design, its function, its risk and its execution plan. We also were given the time to show the Corps of Engineers the nature of Risk/Reward, the multitude of varying execution plans and advantages/disadvantages of each plan. This gives them the ability to combine and optimize these plans for a better overall contract that benefits both owner and contractor. The Corps also developed their prospective contractors' interest in the project in a nonpartisan way. it also demonstrated to the contractors that the Corps is interested in change and optimization of the work.

- o Hope that the COE will develop a better understanding of the contractor's problems and take advantage of his experience.

- o Project information.

- o A better understanding of project and different views of other contractors on the work.

- o As expected.
- o Ideas on what goes through designer's heads.
- o Just what I had hoped for.
- o Minimum expectations met; gained confidence in process.
- o What was expected and more.
- o I really enjoyed the day. I felt that all participants were openly vocal and genuinely constructive in their comments. Possibly, some areas of questionable design may be averted due to the meeting.
- o Lead on potential work.
- o An understanding of the project; interaction with CII; constructability experience; and meeting other contractors.

5. Of the 12 factors listed below, rank order the 7 factors most critical to making a constructability symposium a success. (1 = most important, 2 = 2nd most important, and so on.)

*** number indicates the number of respondents)**

Ranking

2 Facilitator knowledgeable in the type of construction being discussed (1-2*; 2-4*; 3-2*;5-1*; 6-3*)

11 Neutral site for the meeting (10-2*)

4 Owner or A/E reps in attendance who have decision-making authority (1-1*; 2-1*; 3-2*; 4-3*;5-2*; 7-1*)

5 Quality read-ahead packet sent to all attendees prior to the meeting (1-1*; 2-1*; 3-3*; 4-1*; 5-2*; 6-1*; 7-3*;)

10 Proper meeting facility atmosphere (audio-visual support, refreshments, seating arrangements, etc.) (7-1*; 9-1*; 11-1*)

__6__ Selection of qualified contractors to attend (2-2*; 3-2*; 4-3*, 5-1*; 6-1*; 7-2*; 8-1*)

__8__ Project overview briefing given at start of symposium (1-1*; 4-1*; 5-1*; 6-4*; 7-1*; 11-1*)

__3__ Neutral agency putting on the symposium (as opposed to, say, the owner running it himself) (1-1*; 2-2*; 4-2*; 7-1*)

__7__ Well-developed meeting agenda (2-1*; 3-2*; 4-2*; 5-2*; 6-1*; 7-2*)

__9__ Large number of different contracting firms represented (5-2*; 8-1*; 9-1*)

__1__ Owner takes action based on the issues raised in the symposium (1-6*; 3-1*; 5-1*; 6-2*; 7-1*)

___ Other (Please describe)

6. Would you attend a similar symposium for a different project? ___ Yes ___ No (Yes - 12)
If not, why not?

7. Additional Comments:

- o This was a most worthwhile endeavor. Chuck did an excellent job.
- o Please give more advanced notice.
- o Well organized meeting
- o I congratulate you on a well developed and efficiently run seminar. I hope the owner takes the input from the meeting into account for the final design.
- o This was a well run meeting and of great benefit to me.
- o The type of symposium held, the quality of the contractors represented & the expertise of personnel attending should really help the owner to get a hard look at his design and visability.
- o Difficult concept to discuss constructability and efficiency with potential clients while in the presence of competitors.
- o Chuck did a good job facilitating -- this is important and not so much his knowledge of this type of construction, but rather his familiarity of the construction process.

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VITA

William Scott Flanigan was born in Plymouth, Massachusetts on May 27, 1962, the son of William J. and Doris A. Flanigan. After graduating from Marshfield High School, in Marshfield, Massachusetts in 1980, he entered Clarkson University in Potsdam, New York. He graduated from Clarkson University in May, 1984 with the degree of Bachelor of Science in Civil Engineering and was commissioned in the US Army Corps of Engineers. He subsequently served in various command and staff positions with the US Army in the Federal Republic of Germany and the United States. He was married to the former Miss Sonja A. Lasch on June 3, 1989. In June, 1992, he entered The Graduate School of The University of Texas. He is a Professional Engineer in the Commonwealth of Virginia.

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